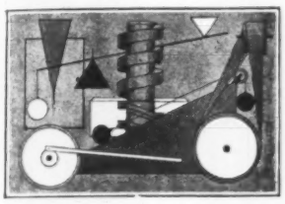
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 | March, 1932 | Number 3



Forthcoming ISSUES

JUDGING from the amount of interest displayed in the series of articles published in past issues on interdepartmental relations of the engineer, there may be some regret that the series now is drawing to a close.

In this issue and the next, however, one of the most important phases of the subject will be covered — the relation between the production man and the engineer. Other aspects also will be treated later if sufficient number of readers wish a continuance of the series.

L. E. Jermy

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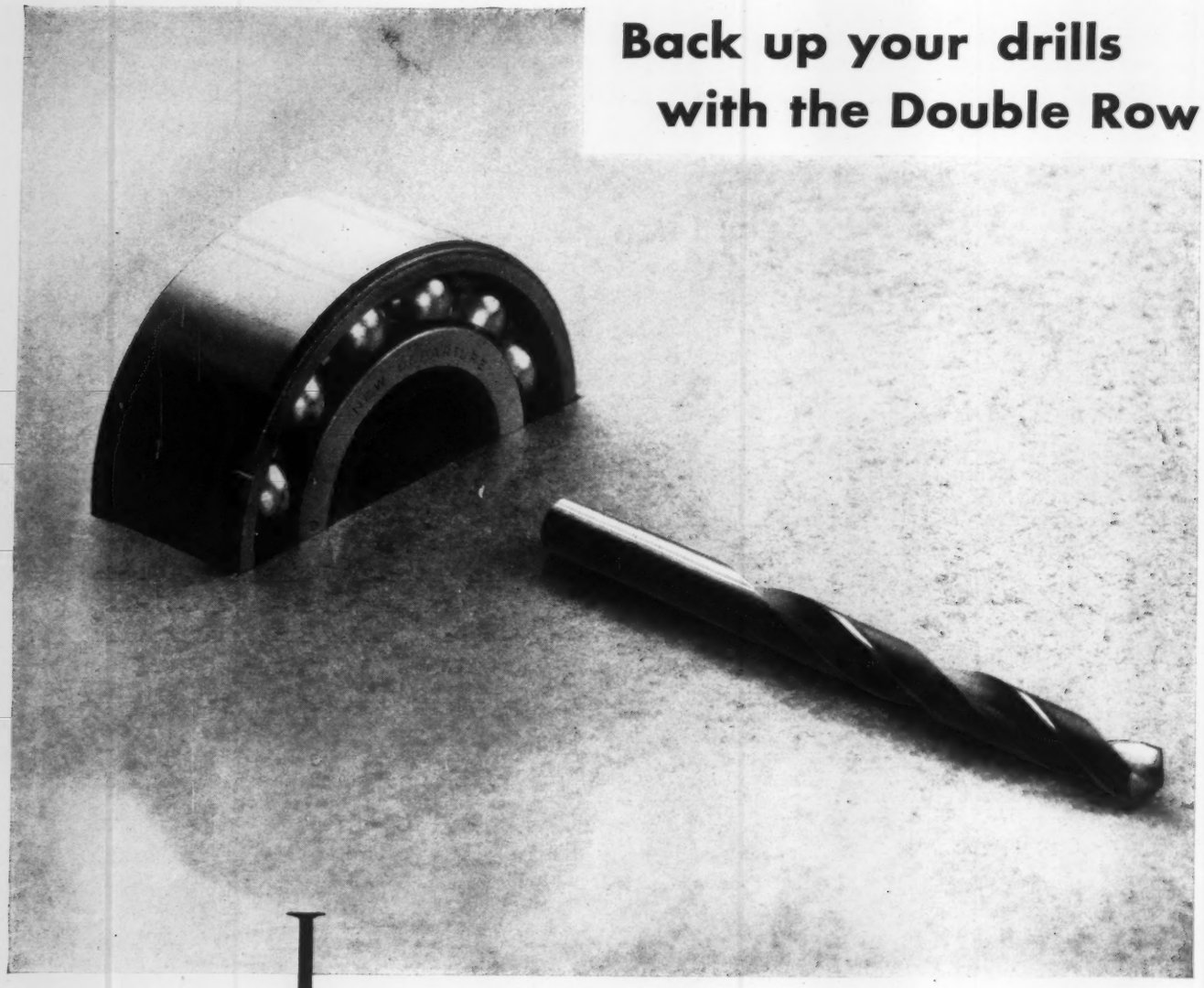

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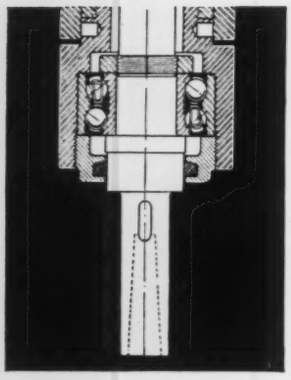

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NEW DEPARTURE BALL BEARINGS

MACHINE DESIGN
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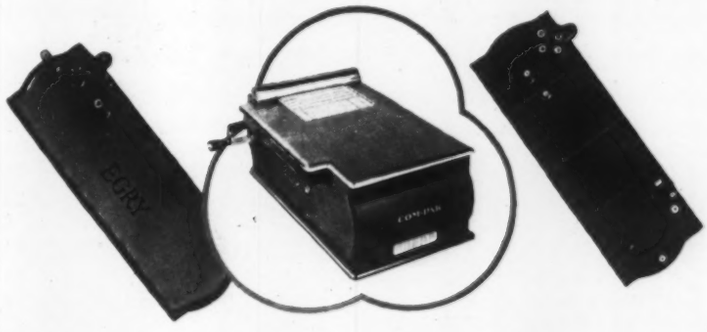
Alertness in Design—A Challenge to the Engineer

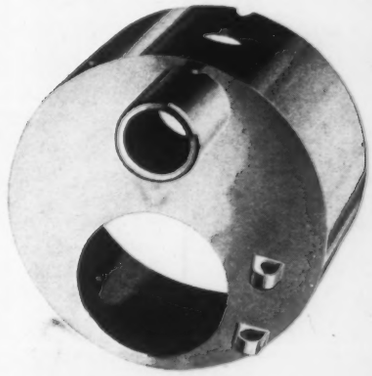
By J. M. Murphy

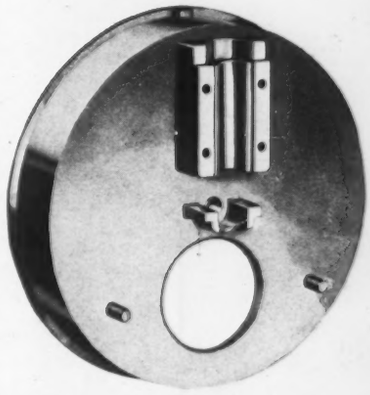
ENGINEERS responsible for design inherently lack commercial instinct. As a rule they fail dismally to look beyond pure mechanical design to the fields of merchandizing. Today is no time, however, to neglect consideration of potential sales features in machines under development. It behooves designers to give scant consideration to precedent and to bend every effort to incorporate in their machines improved features of design that will appeal to the user. Particularly so at present because new ideas, lower costs, faster speeds and vivid eye appeal are more than ever essential in the creation of the urge to buy.

No less an authority than Charles F. Kettering made some pertinent remarks recently on this subject. Asserting that all tendencies of modern civilization are to standardize, he continued: "I do not object to the standardization of, for instance, materials that go into gears. I do object to the standardization of ideas and I object to cutting the pattern of the future from the knowledge of today."

Wide-awake engineers have for some time been giving increasing consideration to thoughts such as these and have opened their eyes to the difficulties en-







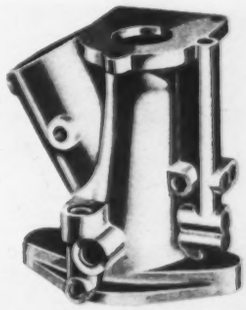


Fig. 1—(Left)—Sides of register are made from molded plastic material. Fig. 2—(Above)—Die casting process is utilized for these two sections of vending machine and the carburetor body

countered in merchandizing the machines they develop. Consequently there has been a more or less concerted attempt to incorporate in their designs the newer materials and processes that are available.

New Features Provide Sales Points

Not only does this have the effect of giving the sales manager and salesmen something tangible to talk about in discussing their products, but advertising managers also are in a better position to feature the machines from the angle of design developments that have taken place. These two considerations are dominant factors because, without them, fewer sales can be made and consequently less money appropriated for development work. And with smaller appropriations for development, less attractive machines and consequently fewer sales are apt to be made. A vicious circle that can have but one result! Yet the number of designers that take these phases of design into consideration of their own free will is relatively small. Those who do are studying every conceivable process that may aid them in creating or redesigning outstanding machines.

A pertinent example is shown in the design of the new noiseless portable typewriter depicted in

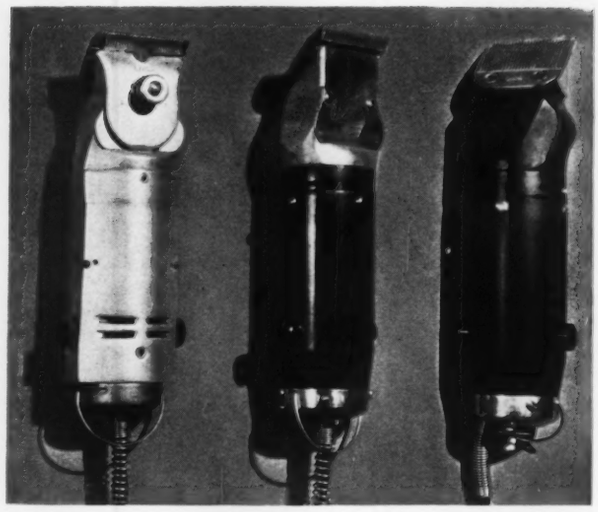


Fig. 5—Designers of this hair clipper appreciated the advantages of lightness and appearance as sales features. Note the change to plastic materials

molded plastic material. This provides a lustrous finish and assists in reducing weight, a distinct asset in any portable machine.

Employment of phenol resinoid products was for some time restricted largely to the electrical field. Since style and appearance have begun to play such an important part in the salability of mechanical units however, the utility of plastic materials is being increasingly recognized.

A typical instance of this is given in Fig. 5, illustrating the changes which have taken place in the design of a hair clipper during the past few years. The use of plastics in this instance not only enhances the appearance of the product and makes it lighter, but facilitates manufacture by elimination of the finishing operations.

Fig. 3—(Right)—Utility of typewriter is increased by making top plate from molded material. Fig. 4—(Below)—Dough mixing machine of steel construction shows advance in welding

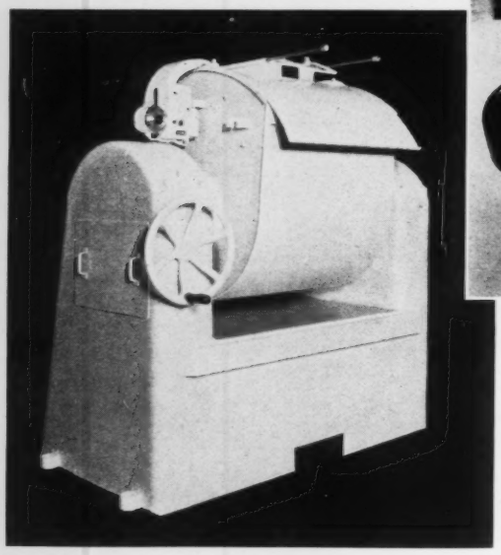


Fig. 3. Besides paying particular attention to an essential sales feature of this unit—appearance—the engineers have taken advantage of one of the newer adjuncts to the materials commonly used in mechanical design and have incorporated an entire top plate, including the housing containing the ribbon spools, made from

Similar economies and improvement in appearance were effected in the change to molded plastics for the sideplates of the register shown in Fig. 1. As a result, from the manufacturing angle, some 23 machine operations were eliminated and a floor space of 5000 feet made available for other purposes.

Another method that is becoming increasingly popular in effecting economy and reduction in weight is the use of pressed steel. Fig. 6 illustrates a fan housing fabricated by this process. By redesigning in pressed metal the weight was reduced 65.3 per cent and net production savings amounted to 30 per cent. In addition an improved product was obtained both from the angle

of finished appearance and reduction of friction in the air chamber.

A railway section car wheel on which pressed steel is used, also is shown in this illustration. The pressed steel wheel is one-third as heavy as the former wheel, weight being reduced from 125 to 47 pounds. In this case weight reduction is particularly desirable, the cars frequently being lifted on and off the tracks by manual labor.

In the field of metals also wider scope now is offered the designer. Corrosion and heat resistant steels, rustless and high strength irons and other comparatively new alloys present opportunities that formerly were unthought of. In many of these alloys nickel plays a major part. An outstanding example of the value of this constituent is contained in the use of nickel alloy steels in the design of a fairly recent Canadian Pacific railroad locomotive. The boiler of the engine is built to withstand a pressure of 275 pounds per square inch, 25 pounds more than that of similar boilers. The higher pressure and a saving in weight of 28 per cent were made possible by employment of these steels.

Formed Parts Facilitate Production

Die castings open up innumerable possibilities for cost reduction and improved appearance in machines. Zinc, aluminum and magnesium alloys are becoming more widespread in their use, and now progress is being made in die casting iron alloys, as well as brass. In Fig. 2 are shown parts of a vending machine with two inserts and a bearing cast in place, effecting a saving in cost of 50 per cent. In addition the time

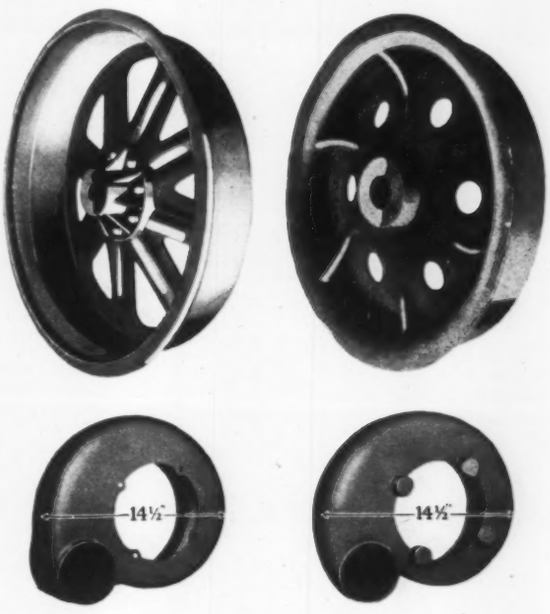


Fig. 6—Pressed steel parts shown at left resulted in considerable economy in production besides improved appearance and reduction in weight

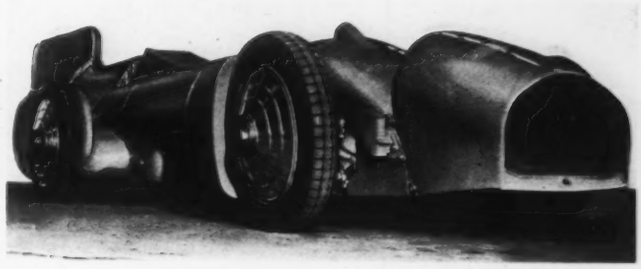


Fig. 7—Alloys containing nickel figure largely in construction of the record-breaking racing car Bluebird III

required to polish the part is cut down considerably. Similar features apply to the carburetor body shown at the bottom of this illustration.

The process of forming parts as brass forgings has undoubted merit. By this method, using virgin metal, a uniform grain structure giving high strength is obtained. This assured factor permits reduced weight without affecting utility.

Similarly with nitriding steel, the new hard-facing metals for deposition by the welding torch present numerous opportunities in applications demanding wear resistance. For tipping shovel teeth or well-boring tools, or for coating the surfaces of parts such as the arms of chemical mixers, these hard-facing materials are worthy of serious consideration.

An instance of the unusual results achieved by welding engineers, particularly from the angle of appearance, is depicted in Fig. 4. This shows a dough mixer which is much more economical to produce than previous models. Welded construction, besides resulting in reduced manufacturing costs, enabled the designers to lower the weight considerably, a particular asset in this instance because these machines often are placed in upper floors of large bakeries. Technique of welding has improved immeasurably during the past year and now has reached a point where machines fabricated by this process compare favorably in appearance with those designed for other forms of construction.

Watch the Other Developments!

The foregoing necessarily represent only a few of the developments which have taken place in recent years that may be utilized by alert designers in effecting economical production, improvement in design and consequent increased salability of their machines. There are many other parts, materials and processes available, all of which should be considered in development work. The engineer who neglects to study them is blinding himself to opportunities he cannot afford to miss.

Credit is acknowledged the following companies for their kind co-operation: Baldwin-Southwark Corp., Eddystone, Pa.; Bakelite Corp., New York; International Nickel Co., New York; Superior Die Casting Co., Cleveland; and Youngstown Pressed Steel Co., Warren, Ohio.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

IDEAS are born of ideas! Now, more than ever in history, manufacturers are searching for new markets. They are depending on engineers to aid them. The situation is tense . . . but if the designer will give thought to the transference of ideas from one branch of the engineering industry to another, he is on his way to a solution of this problem.

Succeeding paragraphs describe five new developments, each characterized by at least one design idea. Engineers studing them with reference to improving their own products, may find the embryo of a new selling point. It is only through concentrated observation of what others are doing that advanced possibilities will be brought to light.

Stop Vibration at Its Source

UNTIL finished design of machines provides as nearly as possible for elimination of vibration, operating efficiency will be impaired. Engineers engaged in machine developments therefore would do well to keep in touch with the introduction of new vibration recording devices and to employ them where possible in preliminary tests before machines are placed in production.

Various types of vibration recorders have been designed including a new instrument just developed in the general engineering laboratory of the General Electric Co. Somewhat like the seismograph for recording earthquake tremors, it measures in thousandths of an inch the vibration in steam turbines and other types of equipment.

Within the instrument case, shown in Fig. 1, which is bolted to the machine under investigation, is suspended a block of lead. Two tension springs on the top and four springs on each side of the weight hold it in position. The outside shell of the detector vibrates at the same period as does the machine to which it is attached, but the lead weight, because of its mass and low natural frequency, remains fixed in space.

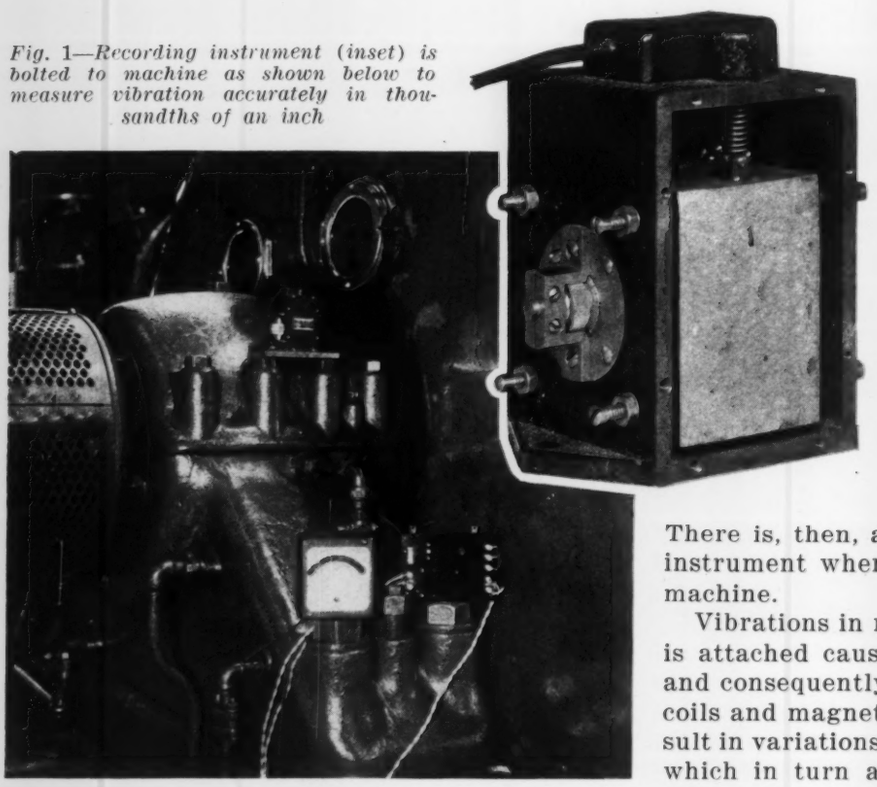


Fig. 1—Recording instrument (inset) is bolted to machine as shown below to measure vibration accurately in thousandths of an inch

Embedded in the lead weight on opposite sides are two coils, and in front of each coil is an adjustable piece of magnetic steel, fastened to the outer shell. These coils are energized by 500-cycle alternating current, and the air gaps between the coils and pieces of magnetic steel are adjusted so that the two coils are balanced electrically—the amount of current passing through the coils depending on the distance of the steel pieces from them. There is, then, a zero reading of the indicating instrument when no vibration is present in the machine.

Vibrations in machinery to which the detector is attached cause a swaying of the outer shell and consequently varying distances between the coils and magnetic pieces. These differences result in variations in the flow of electrical current, which in turn are translated into thousandths

of an inch in vibration readings by the indicating or recording unit.

When the nature and source of vibration in a machine have been determined, the designer need no longer depend on incorporating an accumulation of mass and heavier members to combat this factor. His most effective tools are dynamic balancing, strong but light materials, proper proportioning of gears and careful selection of bearings. By these means the engineer is able to develop machines which will operate with a minimum of noise, are easier to transport, present a lesser problem in floor construction in installation, and will be easier to maintain in service.

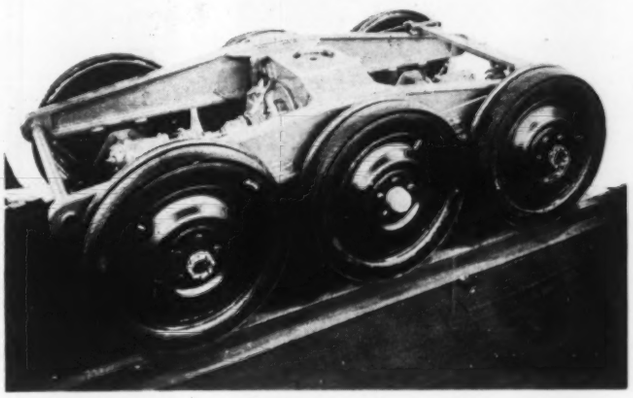


Fig. 2—Pneumatic tires mounted on flanged wheels have been adapted successfully to rail cars

Pneumatic Tires for Rail Cars

FURTHER evidence that the rolling stock of the railroad industry is undergoing decided improvement is revealed by a newly developed stainless steel, self-powered, pneumatic-tired rail car. There is particular significance in this announcement; it marks another progressive step in an industry which has shown comparatively little advancement over many years. At least it has not kept up with the automotive and aircraft industries.

In this new car, recently completed in the Philadelphia plant of the Edward G. Budd Co., is seen the reward of the engineer's originality in employing new materials, parts and processes: Stainless steel, pneumatic tires mounted on flanged wheels, Fig. 2, and a new process of welding; all the work of the technician. The revolutionary vehicle is the result of the combined efforts of the Budd company's engineering staff and the research of the Michelin company of France, which has experimented with rubber-tired, light weight rail cars for several years. This type of car already is in use on certain French railroads and its American counterpart opens up a new field in this country.

The announcement of the first car of this type built here proves conclusively that virtually no industry is standing still; and that the designer who does not join in the progressive march and take advantage of the opportunities offered in new and revolutionary design, is slipping backward.

The Roller Clutch As a Lock

ONE application of a roller clutch mechanism suggests another. Numerous uses have been brought to light during recent months, and the device still retains even more extensive possibilities for designers. One of the newer applications is a quick-operating arrangement for swinging an automobile windshield to any desired angle.

As disclosed by the details in Fig. 3, the unit is operated with one hand, automatically locking the windshield securely in any position from closed to full open by merely releasing the handle. The principle is simple; conventional roller clutch engages a sector secured to the body header by a pivot connection. Clutch rollers engage the adjacent face of this sector and the bearing blocks which are secured within the housing of the device.

Each roller is urged normally in clutching position by a coil spring and is selectively disengaged by means of a shiftable block that is actuated by the knob or handle. By moving this handle in either direction, one of the clutch rollers is moved against the action of its corresponding spring, releasing the particular roller from its clutching action so that the housing and consequently the windshield is moved in accord-

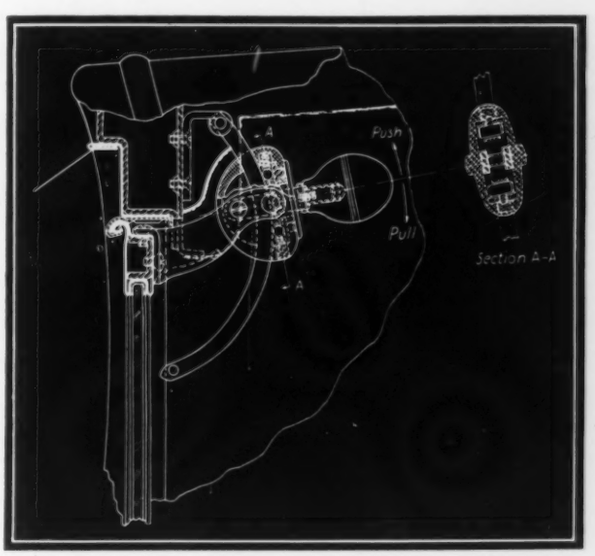


Fig. 3—Roller clutch mechanism provides locking engagement with sector to hold windshield in position

ance with the direction of the handle. During this movement the other roller moves out of its clutching position automatically. When the handle is brought to rest the springs act to place the rollers into clutching engagement, automatically locking in that position on the face of the sector. Application for patent rights have been filed by Motor Products Corp., Detroit.

Making Access to Parts Easier

DESIGNERS now are striving not only for mechanical efficiency but in addition have in mind the man who must maintain the machine and to whom easy access of parts constitutes a major factor in time and effort. One of the outstanding examples of this consideration is characterized by the 12-cylinder Lycoming engine, Fig. 4, with which the Auburn automobile is equipped. In this unit the independent cylinder heads are made distinctive by water-jacketed cover plates which give access to the valves. These facilitate removal of the valves without the necessity of taking off the cylinder heads.

The engine is a 45-degree V-type unit and employs the uneven or "out-of-step" firing which reduces the amplitude of any torsional vibration that may be set up. The two cylinder blocks are cast integral with the upper half of the crankcase. Valves are horizontally located, actuated by vertical rockers from a central camshaft. Helical gears at the front end of the camshaft drive the vertical distributor shaft.

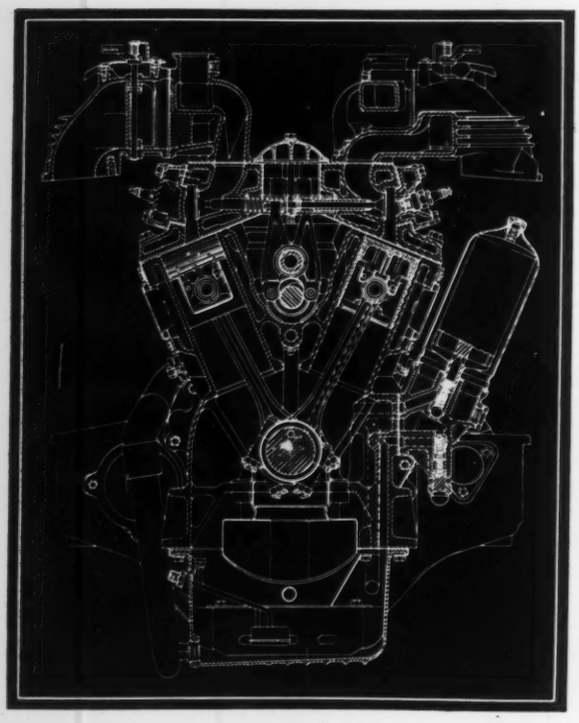


Fig. 4—Easy access to valves characterizes this 12-cylinder V-type automobile engine

Another feature centers around the design of the combustion chambers. In section they resemble an inverted "T" with the major portion of the combustion chamber in the leg of the "T". It is here that the two valves are located side by side, with the spark plugs opposite the intake valve. Each bank of six cylinders has its own intake and exhaust system. One hundred and sixty horsepower at 3500 revolutions per minute is claimed for this engine.

Macerated Material Saves Space

MACERATION of material, permitting packing into limited space is exemplified in the development of a new garbage and refuse collector which promises to replace the old open-type conveyance. The new collector, Fig. 5, was

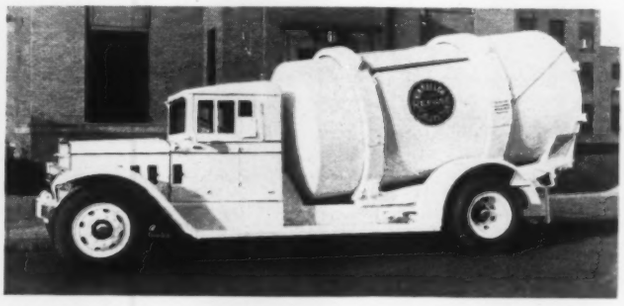


Fig. 5—Welded steel plate tank in which garbage is collected macerates and packs contents

designed in the engineering department of the Baldwin-Southwark Corp., Eddystone, Pa. It resembles in idea, at any rate, the revolving concrete mixers which prepare the batch while enroute from the loading station to the job.

The body of the new garbage truck is a welded steel plate tank provided with doors at the rear end. It is rotated by the truck motor through a pinion which engages a ring gear extending around the outside of the tank and enclosed in a steel guard. Inside the tank are helically-formed steel blades which are welded to its sides. As the tank rotates these blades macerate the garbage and other refuse into a pulp which, as the result of the guiding function of the blades, is loaded compactly into the front of the tank. Thus the rear end is kept free for continuous loading.

As a result of macerating the garbage and packing it into a minimum amount of space, the truck holds three to five times as much refuse as the ordinary open-top refuse cart or truck. Unloading is accomplished with ease. When the tank is placed in the dump position the contents readily slide out. The new type of unit was developed for Cities Service Equipment Corp., New York.

Do Designers Give Proper Attention to Production Problems?

By L. E. Jermy
Editor, Machine Design

WHEN an engineer sets out to design a machine he must bear in mind two important considerations—first, the adaptability of the product to the requirements of the user and, second, its adaptability to the manufacturing facilities that are available.

The first of these involves co-ordination between the design and sales departments. It is a phase of the marketing function and as such was discussed earlier in this series in the articles dealing with the relations of engineers with salesmen.

The second factor, namely the adaptability of the machine to the manufacturing resources, involves the co-operation of the design and production departments. It is a composite of the manufacturing and design functions, and as such constitutes one of the most important problems to be found in the conduct of a machinery manufacturing business. Ability to design a product satisfactorily in all respects to the customer and at the same time conforming nicely to the facilities and abilities of the plant organization and equipment is a highly prized asset. An engineering department capable of effecting the proper balance between these two much desired objectives is in a position to save the company a tidy sum of money.

Obviously much depends on the degree of teamwork displayed by the design and production staffs. In many companies of small or moderate size the functions of engineering and production are so closely interwoven that the possibility of serious conflict between the two is somewhat remote. In larger organizations or in cases where departmentalization of these two functions has been developed along rigid lines there is always danger of misunderstanding or lack of co-ordination. Under any circumstances there is need of harmony between the engineers and production men, no matter how large or small the company may be or how simple or complicated the character of its organization.

If the chief engineer in charge of design has had shop experience he is in a position to work more harmoniously with the production department than contemporaries who have not had such training. In fact, it may be stated with conviction that design engineers should spend considerable time in the plant as part of their preparation for the responsibilities of design work. In the majority of cases it is far easier for the engineer to absorb a working knowledge of production procedure than it is for the plant superintendent or works manager to acquire a familiarity with the principles of design. For this and other reasons it is fair to say that the responsibility for harmony between the design and production departments rests more heavily upon the shoulders of design engineers than upon those of the production men.

In the previous articles in this series, attention has been called to the difficulty experienced by salesmen, purchasing agents and executive officers in understanding the viewpoint of engineers. Shop superintendents

CAN members of design staffs be of greater assistance to production departments? Should they, in trying to foresee possible difficulties in fabrication of the parts they are designing, work more closely with shop superintendents and other works officials? Or do they have, on the average, sufficient knowledge of modern shop practice to enable them to complete their designs without consulting shop men?

These questions are answered from the shop superintendents' angle in the composite letter published on the following pages, giving the views of a number of works officials on design individuals and design department procedure.

—The Editors

do not encounter this trouble in the same degree—probably because they are able to appreciate more fully the problems of the designers. The languages of production and design have more in common than the languages of sales and design, management and design, or purchasing and design.

In view of this closer relationship one might think that the shop superintendent and the design chief should get along as harmoniously as the proverbial peas in a pod. Unfortunately, however, there are several factors which may and often do give rise to more or less serious misunderstanding.

Very often the superintendent comes up through the shop, and is virtually a graduate of the famous school of hard knocks. If he is teamed with an engineer of the "theoretical" type—especially a college graduate who has had no extensive shop experience—then there is bound to be the traditional conflict between theory and practice. A practical man who has come up from the ranks always finds it hard to work with a person who appears to be guided by "book learning" alone.

Another source of misunderstanding is the wide gap in the character of the duties and responsibilities of the two. The shop superintendent has to be a man of decision and action. The measure of his ability is more definite than that of the ability of engineers, purchasing agents, salesmen or other department heads. They deal with intangibles; he deals with realities. When he arrives on the job in the morning he finds a force of workmen and a complement of machines to be kept busy. The work at hand must be executed promptly and at the lowest possible expense. If he is to turn out the work economically there can be no delay owing to improper instructions or to inadequate planning.

How the Shop Man Views the Engineering

BY FAR the most general complaint that can be lodged against design engineers by shop superintendents is that they fail to take into account the many practical limitations which attend the work of transforming ideas, materials and parts into a finished machine.

This fault is prevalent in many forms. From our vantage point in the shop, we witness numerous instances wherein the drawings issued from the design department call for impossible or unnecessarily expensive feats of machining, fabrication or assembly. This may be due to insufficient attention to production problems, to lack of familiarity with the facilities at the disposal of the shop, to an inaptitude for viewing design from a practical standpoint, or to other shortcomings in the make-up of the individual engineer.

A few illustrations will serve to clarify our point. The drawing for a rather intricate casting, several hundred of which were required for a lot of machines then going into production, called for half a dozen bolt holes and one oil hole, the latter to be tapped. At first glance it looked as if the drilling job could be handled easily on a multiple drill but upon closer investigation it was found that the position and direction of the oil hole would necessitate a separate operation. The shop authorities explained to the designer that if the location of the oil hole could be altered slightly the extra set-up could be avoided and the entire drilling job could be done at one clamping of the piece.

The engineer studied the suggestion briefly and then declared that he couldn't see how the hole could be changed. Accepting this decision as final the shop turned out the work according to the drawings. Later when a second batch of these castings came through, the shop superintendent—having examined the assembled machine and noted that the exact location of the oil hole was of little moment—again put the matter up to the designer. This time he succeeded in carrying his point and the design was changed. It goes without saying that the production time was reduced and the cost cut down accordingly.

Sometimes shop practice may have a strong bearing on the selection of material for a given part, yet many engineers overlook this fact. At one time one of us was making air sucker tubes of cast iron. Each tube was about 12 inches long and ¾-inch in diameter with a cored ¼-inch square hole through the center. Why this had been specified in the first place was a mystery, but experiencing considerable grief owing to rejects occasioned by the uncertain nature of the core, the shop superintendent inquired of the design engineer why seamless steel tubing would not answer the purpose. It developed that the possibility of using seamless tubing had never entered the mind of the engineer. He agreed readily to the change and the cost was 80 per cent.

"Tries to combat blind following of established practices"

The foregoing is an evidence of routine thinking and blind following of established practices. There is more of this routine engineering being done today than generally is supposed, even in organizations where we think our design is top-notch. It is the duty of the shop execu-

Everything should "click" when a job gets into the shop.

Whether or not it "clicks" depends in a large measure on the degree of co-operation between the shop and engineering offices in working out the details of design. If representatives of the two departments have had the proper contacts, if the two have exchanged notes as the design progressed and if the questions of materials, processes, tooling, scheduling, etc. have been studied carefully the work will go through the shop with little trouble.

But on the other hand if the shop superintendent has been indifferent, or if the design engineers have been slow to make decisions, reluctant to give full information, insistent upon difficult and unnecessary machining operations, tardy in making known their requirements, or unduly lacking in familiarity with the shop's resources in equipment and skill, then there is bound to be trouble—trouble which spells delay and frequently results in much additional and unnecessary expense.

The accompanying composite letter voicing the opinions of shop superintendents reflects the difference in viewpoints to a marked degree. The shop men, to whom prompt and decisive action is of necessity important, are vexed by what appears to be indecision and fumbling on the part of engineers. They are inclined to believe that the designers waste time and that this loss has to be offset by unnecessary speeding up in the shop. Also they complain that engineers do not consult with them sufficiently in advance of production. Moreover they declare that many designers are not familiar with modern shop practice.

Right or wrong, these charges will be answered next month when the engineers express their opinions of shop superintendents.

Department—By a Group of Works Officials

tive to correct such evils whenever he sees them, but it is even more incumbent upon the engineer to avoid wasteful routine in his original designs.

As shop men we frequently see design that is too elaborate for the work to be performed. Sometimes it is the use of an expensive material or part where a cheaper piece would do just as well. Again it may be an intricate machining operation that can be replaced by simpler methods without affecting appearance or efficiency.

A case in point involved a simple screw eye, used in quantity on a certain type of machine. The design called for a screw eye manufactured from bar stock on an automatic screw machine. Its production involved turning, threading, milling and burring operations. Appreciating the excessive cost of this item, the shop superintendent suggested the substitution of an ordinary bent wire screw eye purchased from a wire products manufacturer. The suggestion was adopted and while the superintendent lost a screw machine job, the company saved hundreds of dollars because the wire product cost only one-fifth as much as the machined screw eye. We think the tendency to "over-design" is sufficiently common among engineers to warrant their serious attention.

"Often cannot see his own shortcomings!"

This collection of opinions regarding design personnel would not be complete without a word as to the element of time in the relations of engineers with shop forces. Our experience compels us to say that many individuals engaged in design do not place a high value on time. Designs and information are late in far too many instances. Decisions which mean a great deal to those responsible for production sometimes are withheld until the last minute. Again there are designers who neglect to consult the shop people regarding projected designs until they are so near to the production dead line that the production chief has little time to plan his work properly.

The result of this tardiness—some of which unquestionably is pure procrastination—is that a mass of drawings is dumped into the shop at the eleventh hour and the entire force has to pitch in and work furiously to make up for time lost in the design department.

The element of time also is important in the handling of changes in designs. We realize that alterations are inevitable; the shop must always expect a few revisions, even after a job is in production. But the timing of such changes as may be unavoidable is important. When the designer rushes into the shops in the morning with an important change that could have been anticipated the previous day, we can offer him little sympathy. We have lost hours of time and our schedule has been disrupted.

Unfortunately few people have the gift of seeing their own shortcomings. The foregoing is offered as a mirror of not-unkind criticism which will permit engineers to see themselves as we see them.

In conclusion we venture the opinion that the designer's work with the shop will be more satisfactory if he will take the trouble to pay more attention to what is going on within its walls. When a new machine is installed he should be among the first to know what it can do and how it fits into the scheme of production. If it offers advantages over other equipment in the plant he should be alert—on his own initiative—to utilize those advantages in his design work.

And above all, let the engineer take us into his confidence the moment a new design is started or an important change is contemplated. We can help a lot when the drawings are in the preliminary stages in pointing out details that will entail trouble in the shop.

Making the Most of Hydraulics

By Carl Morey

Consulting Engineer, Big Rapids, Mich.

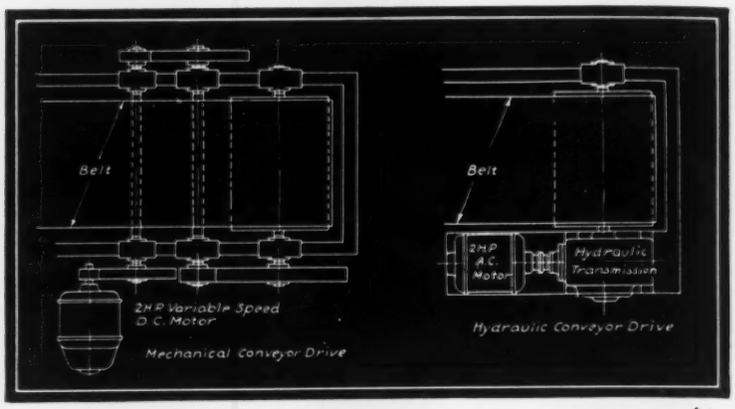


Fig. 1—Comparison between mechanical and hydraulic drives

ROTARY motion was produced by the earliest known applications of hydraulic principles which included overshot and undershot water wheels and the like. Following by many years the development by Archimedes of the water screw, subsequent industrial hydraulics incorporated the cylinder with piston or ram, and the consequent motion was reciprocating.

Designers progressed little further for some time than the cylinder arrangements which also were incorporated in the design of pumps. Most conspicuous of this type probably were presses, and the press idea was adapted to a legion of devices where reciprocating motion and heavy loads were encountered. Modern developments, however, introduced new ideas in which rotary motions again became of first importance. It therefore was necessary for engineers to develop hydraulics which would produce rotary motion, and in this respect they were forced, unconsciously perhaps, to resort to principles that had their birth many years before the actual writing of history began.

As designers went deeper into the matter of rotating hydraulics they conceived the idea of combining the rotating and reciprocating principles and developed high-type devices both as to pumping units and motors.

Special Classification Formed

However, this combination apparatus forms a special class, since it is adaptable to special conditions. These will not be discussed in detail here, although in considering various applications it will be shown where the dividing line occurs between the three basic systems, i.e., throttling, variable displacement, and adjustable displacement. This dividing line, is not defined definitely, since there is an overlapping of such nature that the choice of system adopted frequently is governed entirely by the matter of first cost.

As a basis of comparison, it is reasonable to divide the units of accepted design into two general groups, those that will operate normally above 1000 pounds per square inch working pressure, and those that will not exceed that figure.

It is an interesting fact that the combination apparatus combines the rotating and reciprocating principles and operates normally at 1000 pounds per square inch fluid pressure and above, while those purely rotary normally operate at considerably less.

Pure rotary hydraulics can be summarized to include such devices as gear pumps and motors, vane pumps and motors, and the so-called paddle motor. A wide range of applications is possible with low cost equipment where simplicity, flexibility and reliability are characteristic.

Broadly, it has been stated that any device or machine that will operate satisfactorily with a slippage factor of 4 per cent is suitable for hydraulic applications. Specifically, any device or machine that will tolerate a 4 per cent slippage factor, and requires speed changes in small increments or total flexibility, is ideal for hydraulic application.

Among the first class are all types of material handling equipment that may be operated at constant speed for relatively short intervals but

require some speed variations either in processing or in manufacture. For example, a plating conveyor may be operated at a constant speed for a run of a certain article and then changed to suit the time element of some other article. In conditions where total flexibility is essential and where power requirements are 5 horsepower or less throttling can be used to marked advantage

Fig. 1 gives a comparison between a mechanical and an hydraulic drive of equal horsepower. It will be noted that the hydraulic unit is totally enclosed and is therefore water and dust proof. All gears and moving parts operate in a bath of oil and speed can be regulated from zero to maximum. Two horsepower is transmitted. Actual cost of this drive is somewhat less than a straight mechanical drive which has a variable speed unit with about 20 per cent regulation. Aside from direct saving in first cost, maintenance is lower, and space is conserved. It will be noted that synchronism is more or less unimportant. Regulation is secured on the mechanical drive by using a variable speed direct current motor.

Complications Are Introduced

In considering the drive for a paper machine or rubber calender wind-up, Fig. 2, a new complication is introduced. In analyzing this condition it will be found that as the reel increases in diameter its weight increases and its rotative speed is reduced, as the surface speed is kept constant. It then becomes a matter of moving a light load at high speed or a heavy load at low speed. In terms of torque, it becomes low torque at high speed and high torque at low speed. This characteristic is the reverse of the characteristics of the ordinary throttle hydraulic system previously described.

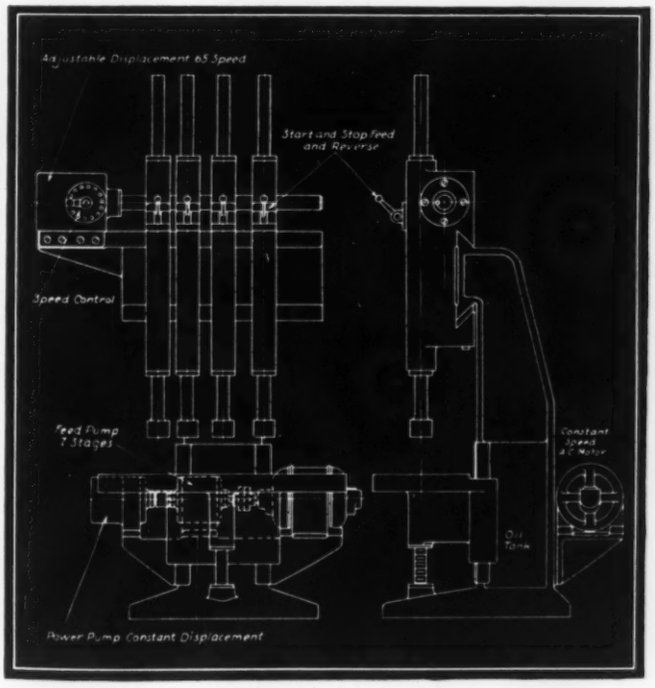


Fig. 2—Drive for drilling machine where speed changes are required for sizes of drills and materials being worked

Speed is dependent upon the volume delivered and torque is dependent upon the effective area

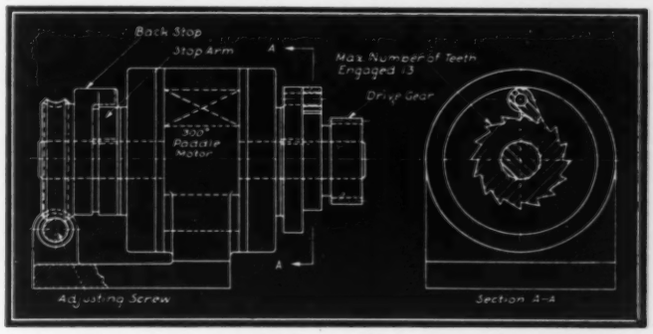


Fig. 3.—A paddle motor actuating a pawl and ratchet direct without the use of a pawl lever

and working pressure at which the volume is delivered. Since in a throttling system the effective area must remain constant, the pressure must increase as the speed is decreased and the volume must decrease as the pressure increases. As the pressure is entirely dependent upon the resistance, it will adjust itself automatically to balance the load. It then becomes a matter of regulating the volume or displacement to meet the speed conditions. Since the excess fluid must pass through the relief valve which is spring loaded, and the discharge area of the valve varies with the pressure in the system, the pressure re-enters the problem, and a valve must be designed with a metering characteristic to regulate the pressure and discharge simultaneously and according to the specific work to be performed. This in turn introduces the matter of fluid velocity which varies directly with the pressure, viscosity, etc.

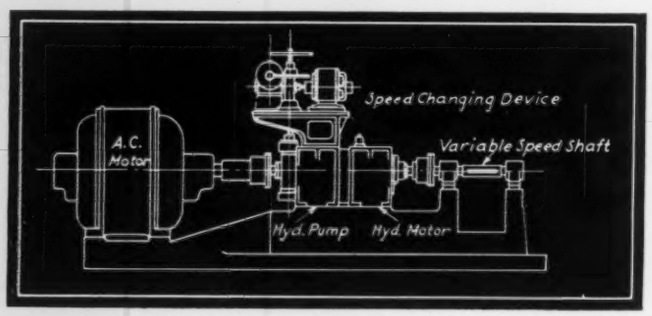
Variables Are Interdependent

Since the variables in this problem vary within themselves and are interdependent, as also is the mechanical construction of the units, it is impossible to calculate the nature of a metering relief valve with any degree of accuracy. The problem becomes one wherein the variable displacement characteristics are favorable. The displacement (volume) can be regulated more or less accurately, and the pressure will vary to balance the load. As the temperature under these conditions does not fluctuate between wide limits, the viscosity remains nearly constant. Therefore, the uncertain elements are reduced materially, if not eliminated entirely. It is obvious, then, that the condition favors variable displacement systems while throttling systems

practically are eliminated from the designers consideration.

In applying the variable displacement system, the displacement of the motor should be altered rather than the pump. This permits changing the effective area of the motor, and the resultant torque characteristics follow closely the requirements. Total amount of fluid being pumped and pressure remain nearly constant.

Frequently conditions occur in design where changes of speed, while varying between wide limits, are acceptable in steps with increments of change similar to a direct current motor drive. However, with this type motor it is difficult to secure the particular speeds required due to its electrical characteristics. With adjustable speed hydraulics it not only is possible to secure as many steps as desirable, but these steps can be arranged to progress either regularly or irregularly. It must be remembered, however, that this apparatus does not synchronize, the variation being somewhere within 4 per cent of that designated.



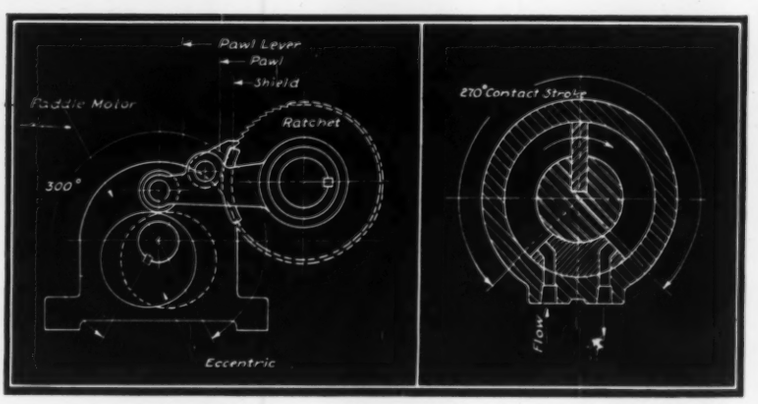


Fig. 4—(Above)—Paper machine drive, or rubber calender wind-up introduces new complications. Fig. 5—(Right)—One of the simplest devices for intermittent feeding consists of a paddle motor rotating through an arc of 300 degrees. In construction this unit is a simple cylinder rolled up in circular form, shown at extreme right

Adjustable Displacement Motor Used

The drive for a drilling machine where speed changes are required for various size drills and various material being worked is shown in Fig. 2. It will be noted that the motor is adjustable displacement having 63 steps of volume (or speed). If 630 revolutions per minute is the top speed, and the increments are uniform, the steps will be 10 revolutions per minute each. Few machines require closer regulation. This type of equipment is suitable for any type of drive or feeding mechanism (allowing normal slip) where pick off gears, change gears, or direct current variable speed electric motors are used. With this system 60 speeds cost about the same as 10 speeds obtained by use of mechanical equipment.

Operate Against Positive Stop

An inherent characteristic of all hydraulic drives is their ability to operate against a positive stop without injuiry to the mechanism. Intermittent feeding mechanisms, in particular, take advantage of this characteristic. Fig. 5 illustrates one of the simplest devices for intermittent feeding. It consists of a so-called paddle motor rotating through an arc of about 300 degrees.

In construction this motor unit is a simple cylinder rolled up in circular form, Fig. 5. To the shaft is attached an eccentric by which movement is transmitted to the pawl arm carrying the pawl, thence to the ratchet wheel. As in the conventional pawl and ratchet, a shield is provided to expose only the number of teeth desired. Where this device acts in conjunction with a reversing cylinder or motor for some other function of the machine it can be piped in parallel and makes one stroke for the forward motion and one for the reverse. If, however, the feed is to take place at one end of the main cylinder or one direction of the motor, a cam can be substituted for the eccentric employed in the design shown in Fig. 4.

This simple arrangement is not economical unless it is an accessory of some other more important hydraulic system of the machine. It would not be advisable to install this device with its own valve and pump on an otherwise mechanical machine. It does not lend itself to large movements as the parts would be proportionately large and costly.

A paddle motor actuating a ratchet and pawl direct without the pawl lever is illustrated in Fig. 3. Even though the ratchet is of small diam-

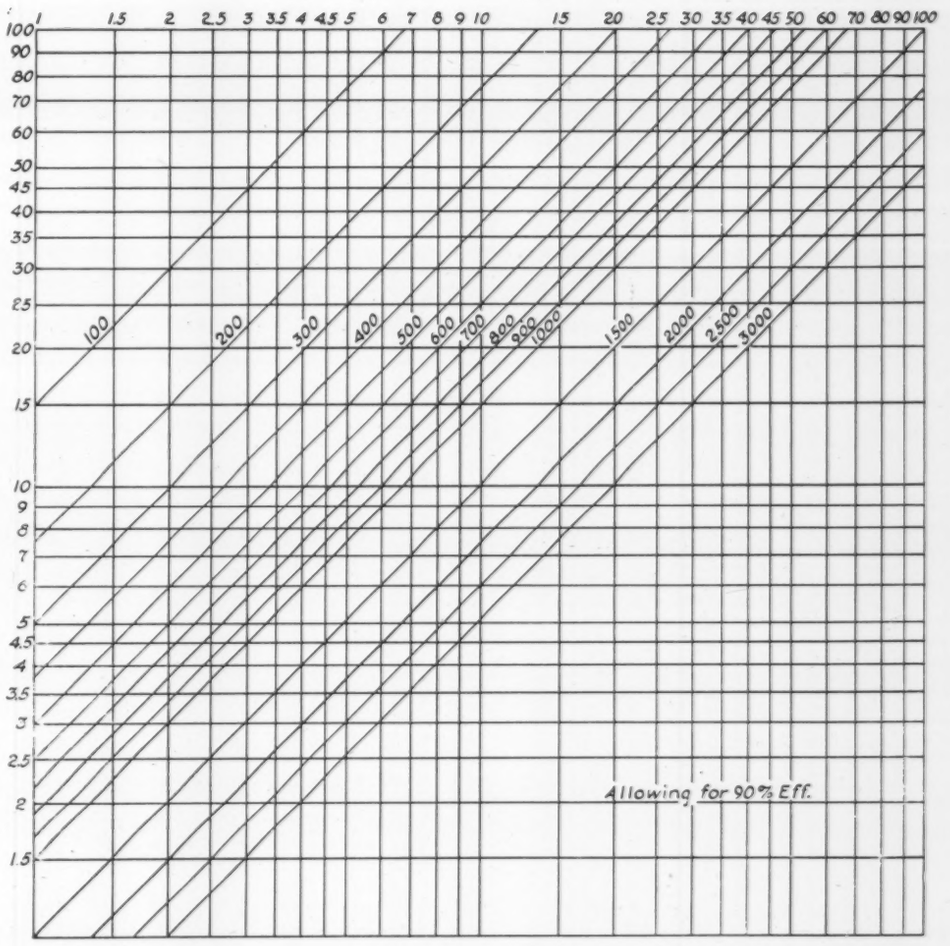


Fig. 6—Chart for determining such factors as horsepower, pressure and gallons per minute for large capacities and high pressures

eter, it has coarse and consequently strong teeth. This device is arranged so that the amplitude of motion of the pawl carrier is regulated for the number of teeth engaged instead of using a shield as in Fig. 5. As the motor is of the simple type (not differential) the power developed on the return of the pawl would be equal to the available power for the forward motion. This is taken care of by introducing a low pressure relief valve in the return line so that the fluid pressure will be limited to 5 to 10 pounds per square inch or just sufficient to move the paddle and pawl carrier to the initial position. The return position of the pawl carrier is regulated. Using this idea as a basis, it is evident that a double acting back stop and double acting pawl will permit of feeds in opposite directions. Introduction of a limited amount of gearing will increase the range of the device.

The design of the paddle motor is quite simple, and its manufacture not particularly expensive. Like all other hydraulic units, it is governed by the same laws as apply to other phases of machine design.

Since it is positive displacement, the number of strokes will be governed by the quantity of fluid available.

Fig. 7 illustrates diagrammatically the various fractions of the paddle motor. In the drawing and the following formulas

y° = to stroke of motor
D = diameter of bore
d = diameter of drum
R = radius of bore
r = radius of drums
W = width of blades

then

$$\text{Effective Area, } EA = R - r \times w \quad \ldots\ldots (1)$$

$$\text{Torsional Moment, } TM = EA \times P \times \left(\frac{R - r}{2} + r\right) \quad (2)$$

$$\text{Displacement, } Ds = \frac{\pi R^2 - \pi r^2 \times y^\circ \times W}{360^\circ} \quad (3)$$

$$\text{Horsepower, } HP = \frac{Ds \times P \times N}{231} \times 0.00058 \quad \ldots\ldots (4)$$

where

P = fluid pressure in pounds per square inch
N = number of strokes

Fig. 6 is a chart for determining such factors as horsepower, pressure and gallons per minute for large capacities and high pressures. This chart in conjunction with that published in the February issue of MACHINE DESIGN covers practically the entire range commonly encountered in industrial hydraulics.

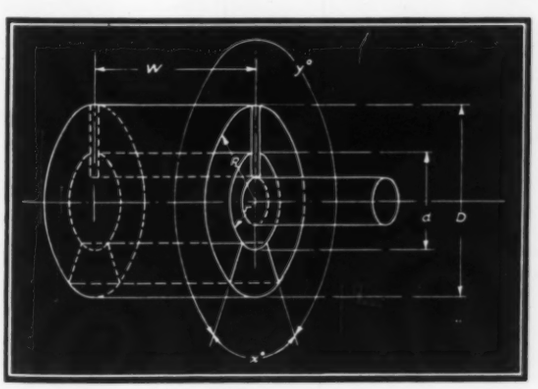


Fig. 7—The various fractions of the paddle motor shown diagrammatically

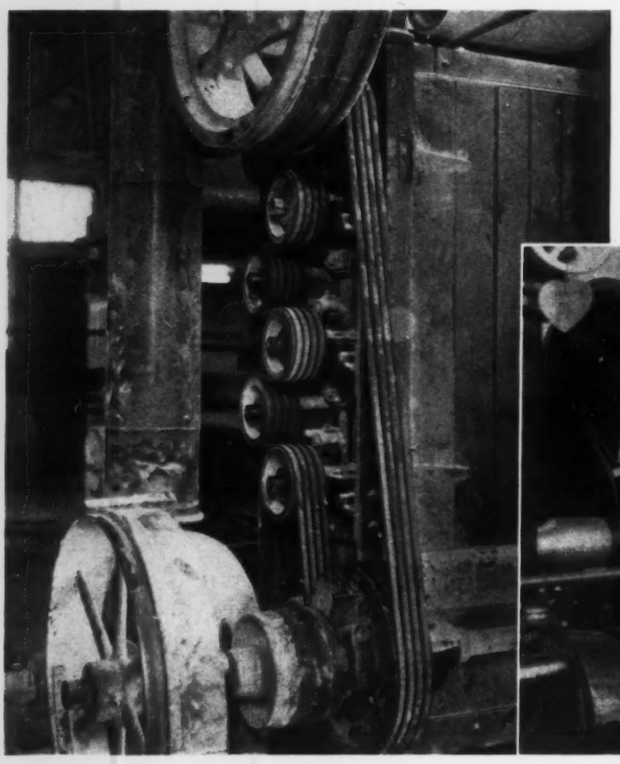
Type of Service a Governing Factor in Design of V

By Allen F. Clark
Editorial Representative, Machine Design

SELECTION of V-belt drives through the extensive tables prepared by manufacturers has become so simple that too often the designer is prone to neglect certain basic characteristics of this type of drive. It appears that all that is necessary is to determine the specifications, look them up in a table, and order the drive. Although the prepared tables are exceedingly well done and cover a wide range, there are a number of considerations to be taken into account in V-belt drive selection on which the ultimate success of the machine as a whole depends.

One of the most important of these considerations, and one which affects every drive whether it is chosen from a table or designed throughout, is the correction factor for unusual service conditions, Table II. Manufacturers have stressed the need for greater driving strength where unusual service conditions are encountered. Engineers responsible for design, however, often overlook the fact that whereas a motor heats up rather slowly and can carry overloads successfully for quite a period, a momentary overload may slip the belts to the point that the frictional heat will destroy them completely. Hence, even though motors may be applied for average conditions, the belts in every case should be applied for peak conditions rather than in accordance with the motor ratings. This is particularly important where the machine is to be subjected to varying loads. The table as prepared gives percentages by which the required horsepower must be increased before the drive is selected, but the drive may be calculated using the required horsepower, and then the number of belts increased by the percentages. The designer should not skimp on the number of belts used.

In designing a drive, it is well to keep in mind the general construction of V-belts. The load is carried entirely by high-tensile, low-stretch cords which are laid parallel to the direction of load. These cords have a ply or layer structure and each ply of cords is insulated from the others by rubber of high fatigue resistance. This construction permits the free play and co-operation of the cord layers as they pass over the pulleys.



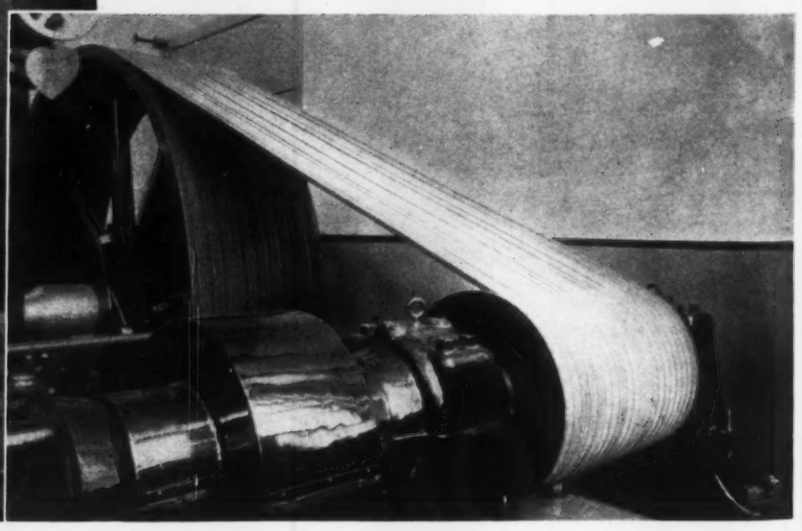


Fig. 1—(Left)—Special type of double V-belt produces conditions similar to a train of gears. Fig. 2—(Below)—500 horsepower drive from a marine engine to a generator

Fig. 4—Large ratios may be used, but in such applications a correction factor for arc of contact or small pulley must be included

V-Belt Drives

The layers of cords are progressively longer from the inside ply to the outside ply, and the belt is made continuously endless.

When a V-belt is flexed over the pulleys the outside half of the thickness is under tension while the inside half is under compression. Near the middle is a neutral plane or area that is neither under tension or compression. The load-carrying cord center of the belt is placed as closely as possible to this neutral area. The sections of extreme tension and compression above and below the neutral section are made of rubber, or a series of convolute layers of a bias-cut fabric; or a combination of both, so that they yield to compressive and tensile forces.

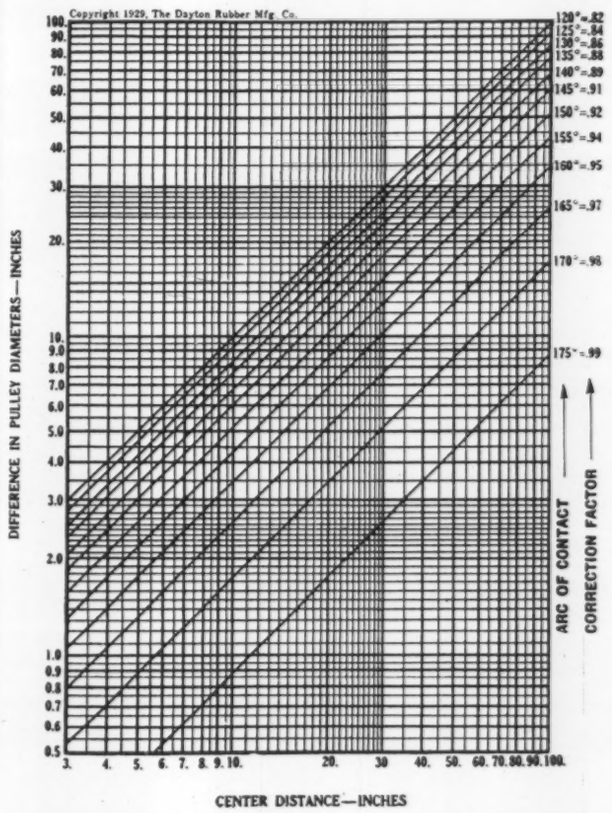


Fig. 3—Chart giving correction factor for arc of contact

The surface wear ordinarily is taken by a fabric envelope with the weave on the bias so that having high elasticity the envelope does not carry tension but allows it to fall on the load-carrying cord center as provided in design.

There are a number of variations from the standard design. One model has the sides cut on a curve to insure a flat surface when the upper portion of the belt narrows down under the influence of the tensile forces. Another has a

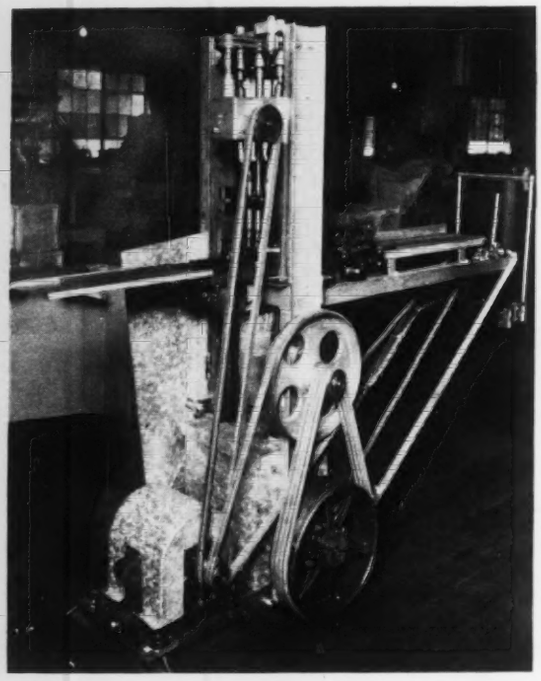
TABLE I.

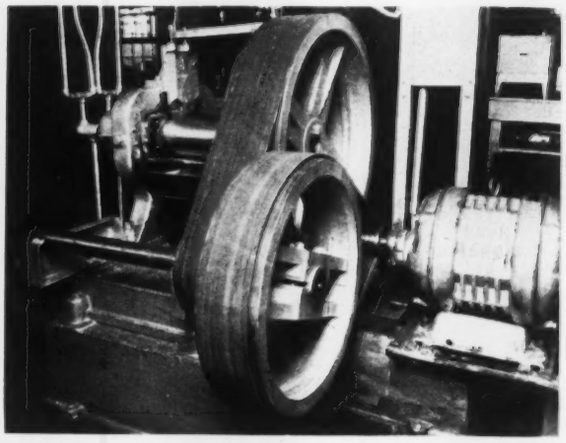
Horsepower Rating Per Belt

Belt Speed Ft. per Min.	A Belts $\frac{1}{2}$ x $\frac{11}{32}$	B Belts $\frac{41}{32}$ x $\frac{7}{16}$	C Belts $\frac{7}{8}$ x $\frac{5}{8}$	D Belts $1\frac{1}{4}$ x $\frac{3}{4}$	E Belts $1\frac{1}{2}$ x 1
1000	0.9	1.2	3.0	5.6	7.5
1100	1.0	1.3	3.2	6.0	8.1
1200	1.1	1.4	3.5	6.5	8.8
1300	1.1	1.5	3.7	6.9	9.5
1400	1.2	1.6	3.9	7.4	10.1
1500	1.3	1.7	4.2	7.8	10.8
1600	1.4	1.8	4.4	8.3	11.5
1700	1.5	1.9	4.6	8.7	12.1
1800	1.5	2.0	4.8	9.2	12.8
1900	1.6	2.1	5.1	9.6	13.5
2000	1.7	2.2	5.3	10.1	14.1
2100	1.8	2.3	5.5	10.6	14.7
2200	1.9	2.4	5.8	11.0	15.3
2300	1.9	2.5	6.0	11.5	15.9
2400	2.0	2.6	6.2	11.9	16.4
2500	2.1	2.7	6.4	12.4	17.0
2600	2.2	2.8	6.7	12.8	17.5
2700	2.2	2.9	6.9	13.3	18.1
2800	2.3	3.0	7.1	13.7	18.6
2900	2.4	3.1	7.3	14.1	19.1
3000	2.4	3.2	7.5	14.5	19.6
3100	2.5	3.3	7.7	14.8	20.1
3200	2.5	3.4	7.9	15.2	20.6
3300	2.6	3.5	8.1	15.5	21.1
3400	2.6	3.6	8.3	15.8	21.6
3500	2.7	3.7	8.5	16.1	22.0
3600	2.7	3.8	8.6	16.4	22.4
3700	2.7	3.9	8.7	16.7	22.7
3800	2.8	4.0	8.8	17.0	23.0
3900	2.8	4.1	8.9	17.2	23.3
4000	2.8	4.2	9.0	17.5	23.5

For belt speeds from 4000 to 5000 ft. per min. use horsepower rating at 4000 ft. per min. For belt speeds over 5000 ft. per min. consult the engineering department of a manufacturer.

Fig. 5—(Below)—Power from one motor is converted easily to a number of different applications. Fig. 6—(Right)—A double reduction V-belt drive used on a rubber mill





cog construction on the under side to facilitate flexing. Other types of belt are constructed to permit reversal, or form a double-V to give double driving surfaces, Fig. 1. It can be seen from the construction of these belts that the standard design would not be suitable for back bends. Belts of uniform cross section have been used in applications with lower speed ratios and ordinary service conditions with a flat pulley as the larger pulley, Fig. 5. Here, however, extreme care must be taken in specifying the belts.

V-belts as a whole are just as hardy as any other type of transmission. They will withstand dust, dirt, fumes, and moisture to the same degree as other recognized mediums. However, since V-belts are made of rubber and fabric, they should not be subjected to oil or excessive heat. Any rubber and fabric material is affected quickly by these two conditions. As a rule, 130 degrees is the highest temperature to which the belts should be subjected. Where the drive is to be enclosed as an integral part of a machine, some type of ventilation such as louvers or screens, should be used to minimize the heat insofar as possible. With simple precautions of this kind, however, there are few, if any, applications where trouble will be encountered from this standpoint.

Incorrect selection of sheaves can have a great deal to do with the generation of unnecessary heat. The belt is designed to ride between the sides of the groove, but should never touch the base, Sheaves which correspond with the size of belt chosen are included as part of the drive by most manufacturers. No other sheaves should be used than those designed for that belt.

Provision in the design should be made for increase in center distance due to "running in" of the belts. The belts are sized exactly during manufacture, but an increase in length of about 5 per cent usually is experienced as during the initial stages of operation the fibers will become matted down, causing the belts to seat themselves deeper into the grooves. The best form of takeup is the use of slide rails under the motor, but an idler may be used. Here, however, the idler should be applied to the under side of the belt and provision made in the design for reduction of arc of contact on the pulleys. Where it is impossible to provide take-up, the problem should be referred to the manufacturer.

Must Guard Against Misalignment

Slight misalignment is not particularly harmful on V-belt drives as the belts adjust themselves readily to irregularities, being guided into the grooves by the shape and construction of the belts. The misalignment permissible depends on the center distance and cross section of the belt. A V-belt drive will stand more misalignment than many types of transmission, yet it should be avoided wherever possible, inasmuch as it will, of course, shorten the life of the belts to some extent. Naturally, the misalignment not only will cause a part of the contact to be lost, but also will cause the belts to scrape or rub against the edge of the groove in entering and leaving. With long centers a given amount of misalignment would not be as detrimental as with short centers. Where extreme misalignment is necessary, such as on axle lighting generator unit drives on railroad cars an especially designed belt and groove is capable of accommodating a misalignment of 9 degrees, necessary when a car passes around a curve since the truck axle pivots whereas the generator is fastened securely to the body of the car.

With the belts sized exactly and fitting into grooves, it can be seen that the problem of replacement will be of considerable proportions

unless it is provided for in the original design. Overhanging the machine or driven pulley instead of using an outboard bearing will facilitate belt replacements and incidentally be a feature of the finished machine.

Regarding the matter of belt speeds, the most practical limits are from 1000 to 5000 feet per minute. It is possible to operate beyond these limits, but in such cases the belt manufacturer should be consulted. The most economical belt speed has been found to be about 4000 feet per minute, although sheaves large enough to obtain such speeds are not always practical. The smaller the diameter, the lower the belt speed, and the higher the cost because more belts are required to transmit a given amount of power.

Drive Proportions Important

More belts mean wider pulleys and increased bearing pressures. When the overall width of the V-belts is equal or less than the diameter of the small pulley, the drive has fairly good proportions. This practice, however, has been exceeded with good results where conditions were made to suit. Below 1000 feet per minute V-belts operate satisfactorily, but the cost usually is prohibitive and the proportions of the drive so large in diameter or extremely wide in face as to be undesirable.

There really is no limitation as to the largest diameter sheave permissible, conditions permitting, since that is governed by the length of belt available and the maximum allowable ratio. In many installations the size and location of a machine is the determining factor as to the maximum diameter sheave that can be accommodated.

Ratios included in the usual tables are for from 7:1 to 1:1. Some tables have been prepared for ratios up to 10:1 and a number of such drives have been designed, but conditions must be correct for ratios of this size. For higher ratios the center distance must be increased sufficiently to permit an arc of contact on the small pulley of at least 120 degrees. This limit also is standard practice on regular drives falling within the speed ratios of 1:1 up to 7:1. As a rule the applications requiring ratios greater than 7:1 are few, and when ratios much higher are involved it often is more economical to apply a gear reduction unit, or a double reduction drive such as shown in Fig. 6.

A V-belt drive will be well proportioned when the center distance equals or is slightly greater than the large sheave diameter. On small ratios, the sheaves may be operated so closely together that the sheave peripheries almost touch each other. Incidently the rule concerning center distances hold true on high ratios as well as those below 7:1.

The horsepower of the belts, given in Table I for sizes built by most manufacturers, is based on an arc of contact of 180 degrees. In the applications where the speed ratio is other than 1:1, the arc of contact and the horsepower obtainable from each belt will be reduced. The revised or actual horsepower is determined by means of a correction factor taken from a table or a chart such as the one shown in Fig. 3. The

TABLE II

Correction Factors for Unusual Service Conditions

Service Conditions	Type of Machine	Percentage to Increase Rated Horsepower of Drive Above Normal Load
Starting load light— Operating load normal	Light fans and blowers Small centrifugal pumps	0
Light pulsations— Starting or peak loads up to 125% of normal	Small pumps and compressors Line shafts carrying light loads	10
Motors started on full voltage	Linestart motors	20
Moderate shocks or pulsations— Starting or peak loads up to 150% of normal	Reversing drives Large compressors and pumps Saw mill machinery (Resaws, hogs, etc.) Clay working machinery. (Augur and pug mills, dry pans, etc.) Paper mill machinery (beaters, jordans, etc.) Large fans and blowers (mine fans, etc.) Large feed mills and pulverizers	25
Severe shocks or pulsations— Starting or peak loads up to 200%	Mining machinery (Ball, rod, and tube mills, crushers, etc.) Mud pumps Drives for continuous operation Small feed mills (hand fed)	40
Starting or peak loads up to 250%— belts to run loose for shock absorption	Textile machinery (spinning frames, twisters, etc.) Machines subject to frequent starting	40-50
Stalling tendency	Crushers, drag lines, and other machinery driven by slip ring motors	75-100

required horsepower is determined, then the number of belts found by dividing the required horsepower to which has been added the service factors, by the horsepower provided by each belt as corrected for arc of contact. This correction has been made in the standard tables. The size of belt best suited for the various ranges of horsepower is,

Horsepower	Belt Cross-section*
Up to 2	A
2 to 5	A or B
5 to 10	B
10 to 25	B or C
25 to 50	C
50 to 100	C or D
100 to 150	D or E
Above 150	E

*For cross-section size see Table I.

All speed ratios between sheaves are based on the pitch diameters of the sheaves. Outside diameters of sheaves are secured by adding to the pitch diameters the values recommended by the manufacturer of the drive. There also are minimum sheave diameters which will give the longest life. The permissible minimum will be perfectly correct and allow the drive to function properly, but the life of the belts will be reduced. To make the belts still more flexible to permit operation over smaller diameters than recommended would render the belts unsuitable for medium or long center distances on account of lacking proper rigidity. Representative minimums are,

Section	Recommended Minimum, Inches	Permissible Minimum, Inches
A	3 ½	2 ½
B	5 ½	4 ½
C	9	7 ½
D	13	11
E	21	17

In this discussion of V-belt drives, no attempt has been made to present complete information necessary for the design of such equipment where unusual conditions are to be met. The points developed are a few of the most important considerations for normal drives. All V-belt manufacturers have available complete tables of standard drives and formulas necessary for the design or selection of unusual drives.

For assistance in preparing the material in this article and for the illustrations used, MACHINE DESIGN acknowledges the co-operation of Allis-Chalmers Mfg. Co., Dayton Rubber Mfg. Co., Dodge Mfg. Corp., Gates Rubber Co., L. H. Gilmer Co., Manhattan Rubber Mfg. division of Raybestos-Manhattan Inc.

Combining Castings with Welded Structures

By J. G. Ritter

EMPLOYMENT of welding in the construction of machine parts has increased rapidly in the last few years, until it now can be considered as fundamental a process as riveting or casting. Recent experience has established quite definitely the economical dividing lines between th different methods of construction. Relative cost of a riveted to welded structure is quite easy to determine, being largely a comparison of the actual cost of the riveting operation to the welding. Comparison of the cost of a welded structure with a casting becomes much more complicated, especially when the manufacturer operates a foundry.

IN fabricating machine parts by welding, it may be more economical to employ castings rather than steel shapes. In the accompanying abstract of a paper presented at a recent meeting of Steel Founders' Society of America, Mr. Ritter, Westinghouse welding and foundry engineer, brings out the salient points to be considered in using one or the other method or both.

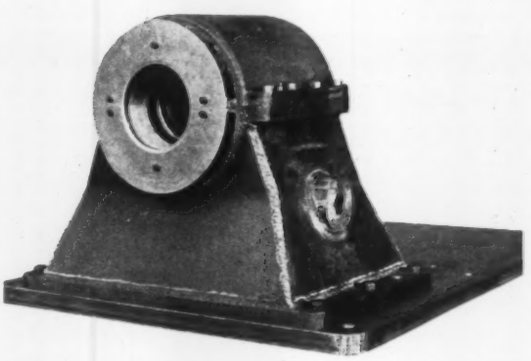


Fig. 1—Extremely short centers are possible with relatively large ratios. The driven portion of this drive is a flat pulley

The most important factor involved is the number of pieces which are to be made. If there are only a few pieces the saving of the pattern cost usually insures a cheaper construction in welded steel. Fig. 1 shows a bearing pedestal of welded construction which can be made more

economically by casting if more than four of one design are needed.

When the activity is high the pattern does not affect the cost comparison to any extent. The pattern cost usually is about the same as that of jigs and special tools required for the high production of welded structures. In synchronous motors, made in large numbers for instance, the frame, rotor and bedplate are of welded construction while the bearing pedestal is cast iron. It has been established that bedplates of welded construction are the most economical regardless of the quantity involved. This is due to the fact that this type of structure has a relatively small amount of welding and fitting for the weight involved. They are constructed of standard rolled shapes, cut to length and fitted with little labor and waste material. This is contrasted with the motor frame which is constructed by burning

Fig. 2—In making welded steam turbines some of the parts with cored passages are cast and then welded to the rest of the structure

annular rings from a plate with a high labor cost and scrap ratio.

There is another factor other than cost which often is involved when deciding on which form of construction is to be used. This factor is the question of quick delivery. The welded type has an unquestioned advantage here.

In general, the welded structure does not have as great an advantage over steel castings as it does over gray iron castings. This is due to the fact that cast steel is equally as strong as the rolled steel used in welding. When replacing an iron casting, the welded construction can be made much lighter and the welds do not have to be large in order to produce a structure comparable in strength. In steel, however, the design has to be followed almost exactly and the welds have to be large enough to develop the full strength of the steel sections

Often the cost of a welded structure is increased materially because some parts of it are quite complicated and require a relatively large amount of labor. The logical thing to do under such conditions is to construct these parts of steel castings and then weld them in place. Cast steel with a carbon content of 0.30 per cent and under can be welded as successfully as the rolled steel. Higher carbon and alloy steels can

Fig. 3—Main trunnion supports of this gyroscope are steel castings welded to the fabricated structure

be used if the proper welding procedure is employed.

A recently designed circuit breaker tank has a cast steel ring welded to its top rim. Various pockets and brackets are combined into the single casting. It is machined and drilled complete and then welded to the tank. The tank is rotated by a turntable and the weld deposited by an automatic welding head. This form of construction insures a good gasket fit for the top as well as low manufacturing costs.

In making welded steam turbines there are several points where castings are used to advantage. Some of the parts with cored passages are cast and then welded to the rest of the structure, Fig. 2.

The apparatus shown in Fig. 3 is the main frame of a gyroscope which is used to control the oscillations of a large ship. The main trunnion supports are steel castings welded to the main fabricated structure.

Welded construction unquestionably has taken a definite place in machine construction, but there is no doubt that some of the features which make it economical also can be used to lower foundry costs. The welded designs are inherently simple with straight sides, small radii at corners, few holes and other features which would lower pattern and molding costs.

The recent increase in the use of welded structures is due to the data on improved welding methods and design suggestions which have diligently been called to the attention of engineers. Foundry practice is so old that it has been more or less taken for granted, and a great deal of benefit would be derived if additional effort were expended in assisting designers with suggestions enabling them to take advantage of modern foundry methods.

By E. H. Hagen

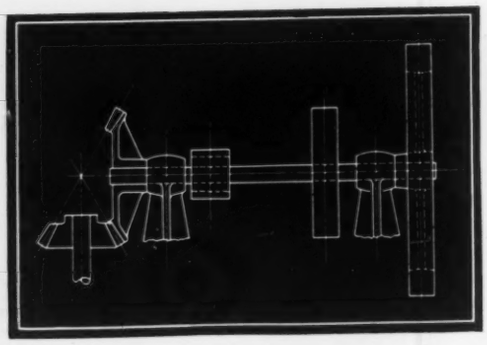


Fig. 1—Shaft used in hypothetical problem for determining greatest bending moment resisted

Visualizing Bending Moments By Graphical Solution

GRAPHICAL methods, aside from often being less tedious and difficult than analytical methods, offer the advantage of visualizing the problem being solved. When the forces acting on a given machine member are represented by vectors, this ability to visualize the forces and their effects often enables a better and more economical distribution of material to be achieved. Careful drawing and the correct choice of scales will produce results comparable with those to be obtained from the ordinary 10-inch slide rule. In general this accuracy is greater than warranted by existing knowledge of the strengths of the usual run of present day commercial materials available to the designer.

Combining Moments Graphically

Bending moments are vector quantities and hence can be combined graphically. This will be illustrated by determining the location and magnitude of the greatest bending moment resisted by the shaft in the hypothetical problem illustrated by Fig. 1. Neglecting the shaft and spur pinion weights, which are small, the forces acting on the shaft are shown in Fig. 2, T_1 and T_2 being the belt tensions acting on the pulley, L the tooth load on the spur pinion, and W_F, W_P, and W_{BG} the weights of the flywheel, pulley and bevel gear respectively. A, B, and C are the vertical, thrust, and tangential components respectively of the bevel gear tooth load.

In Fig. 3 the vertical bending moments have been plotted to some convenient scale and according to the two rules given in the following paragraphs:

1. If a transverse external load is applied to a beam or cantilever thereby producing internal tensile and compressive fiber stresses, the bending moment is designated as *positive* when a *compressive* stress is produced on the *same* side of the beam as that of the load application and *negative* when the fiber stress is *tensile* on the side of the load application.

1A. *Positive* bending moments are plotted on the *same* side of the beam as the load application and *negative* on the *opposite* side.

2. Bending moments which exist *behind* the plane of the paper are swung to the *right* and those in *front* to the *left*.

The method of applying these rules will be made clear by observing in detail how the moments

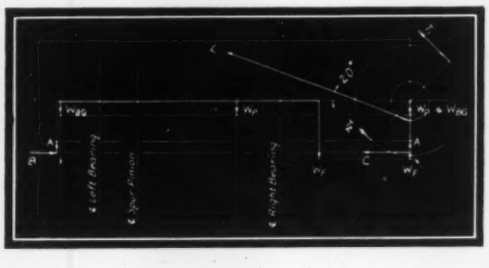


Fig. 2—Forces acting on the shaft shown in Fig. 1 neglecting shaft and spur pinion weights which are small

produced by several of the forces have been plotted.

The force W_F produces a moment which is maximum at the center of the right bearing. The moment diagram is L-10-5 on Fig. 3, the intercept R-10 representing (to scale) the maximum moment at the right bearing due to W_F. In Fig. 2 W_F is represented as pulling down from the underside of the shaft. The underside of the shaft is in compression, therefore according to Rule 1 the moment is positive and according to Rule 1A the moment is plotted on the same side as the load application, in this case below the shaft center line.

Force W_P also is indicated as being applied to the underside of the shaft and this force produces a tensile stress in the underside (the load application side) of the shaft. Hence the moment is negative and plotted on the opposite side of the load application or above the shaft center line, as shown by L-4-R in Fig. 3.

The moment diagram for force A is represented by 1-3-R, for force B by 6-8-R and for weight W_{BG} by the moment diagram 2-11-R. When the individual vertical moments are added vectorially the broken line 6-7-8-9-10-5 is

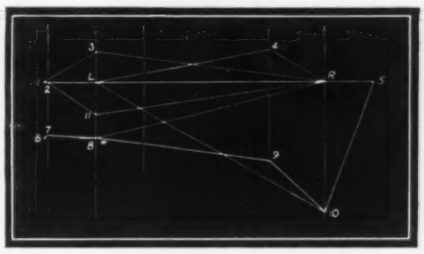


Fig. 3—Vertical bending moment of forces acting on the shaft plotted to a convenient scale

obtained, which is the resultant of all moments in the vertical plane.

The moments produced by forces T_1, T_2, L, and the horizontal force C now must be plotted and combined with the vertical resultant. For the sake of clearness this is shown in a separate diagram, Fig. 4. The vertical resultant 6-7-8-9-10-5 has been transferred from Fig. 3. T_1 and T_2 act at 45 degrees from the horizontal and vertical. Fig. 5 shows the sum of these forces and the direction of their line of action with respect to the vertical plane V-V-V (the plane of the paper) and the horizontal plane H-H-H. The center line of the shaft coincides with the line of intersection of the horizontal and vertical planes. It is seen that the force $T_1 + T_2$ produces a negative bending moment (Rule 1), and therefore the moment 13-14 is plotted on the opposite side of the shaft (Rule 1A). The moment diagram is then L-14-R, L and R being the centers of the left and right bearings respectively. The moment diagram is then in the quadrant lying below the horizontal plane and behind the

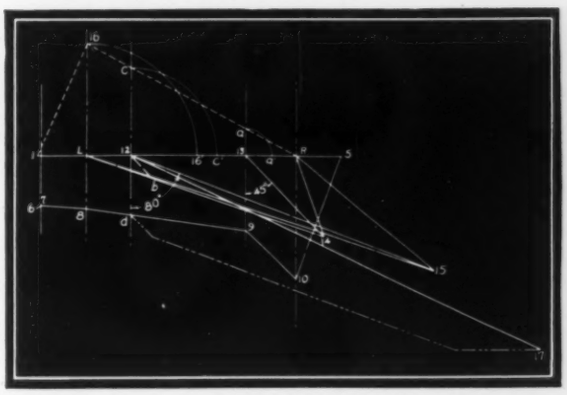


Fig. 4—Moments produced by forces T_1, T_2, L, and the horizontal force C

vertical plane V-V-V, that is, behind the plane of the paper. So by Rule 2 the moment 13-14 is swung to the right in Fig. 4. In this figure, L-14-R again represents the moment diagram produced by $T_1 + T_2$.

Brief study will show that the bending moment produced by force L is also negative and lies behind the paper plane. Therefore this moment 12-15 is also swung to the right, the angle being 80 degrees from the vertical since force L acts 20 degrees from the horizontal or 80 degrees from the vertical. Force C, being horizontal, produces a moment diagram lying in the horizontal plane with the maximum moment at L equal to L-16′, the moment having been swung to the right since this moment diagram of force C also lies behind the plane of the paper. However, with the moment drawn in this position it is impossible to picture clearly how the moment varies at different points along the shaft. Therefore the entire moment diagram has been swung upward 90 degrees into the plane of the paper and is shown by the broken line 1-16-R.

Extra Figures Constructed

The resultant moment at any point along the axis of the shaft now may be determined. Consider the conditions existing at 12 under the spur pinion. Here is found the vertical moment 12-d, moment 12-b (12-b having been drawn parallel to 13-14), moment 12-15 and the horizontal moment 12-c' which is equal to the intercept 12-c. Standing at R and looking toward L the magnitudes of these moments and their directions will appear as shown in Fig. 4. The resultant of these moments can be obtained in the usual graphical manner as shown in Fig. 4A. This can be done directly on Fig. 4, thereby eliminating the need of constructing Figs. 4 and 4A. This has been done by beginning at d to plot moment 12-b and successive moments as indicated by the broken line. The resultant is 12-17. A brief inspection will show that the resultant at L of the two moments L-8 and L-16′, and the resultant of all moments at 13, will be less than the

resultant at 12 and so they have not been obtained.

The six figures used to illustrate the graphical method described may give an air of complexity to the method. In reality the method is a simple one after the few fundamentals involved are understood. Only one diagram, Figs. 3 and 4 combined, need be drawn in actual practice. The information shown in the first two illustrations is obtained from the usual design layouts and calculations. Figs. 5, 6*A* and 6*B* have been drawn only in the attempt to illustrate some point in the process of developing Fig. 4.

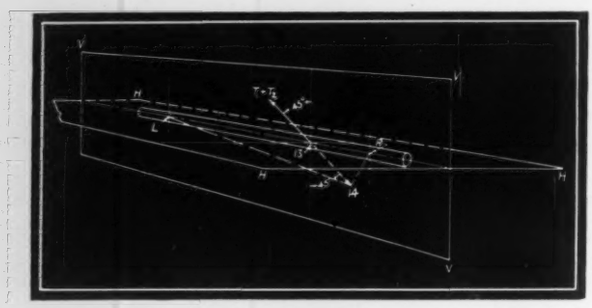


Fig. 5—Sum of the forces shown in Fig. 4 and the directions of their lines of action

Resultants Not Obtained

It is interesting to note that if the actual resultants in this problem had not been obtained by either the analytical or graphical methods, the designer would have designed the shaft on the basis of the stress produced by the largest single bending moment; that is, by the moment 12-15 produced by the load *L*. If the true maximum moment 12-17 and 12-15 are scaled it will be found that the true maximum moment is 40 per cent larger than 12-15. In highly stressed shafts it is good practice, therefore, actually to obtain a true picture of the moments and stresses involved.

Where shafts transmit considerable torque, such as in the case in Fig. 1, the moments obtained from Fig. 4 are combined with the torque moments with the help of the formulas and charts given on page 30 of the January, 1930 issue of MACHINE DESIGN or pages 28-30 of the August, 1930 issue.

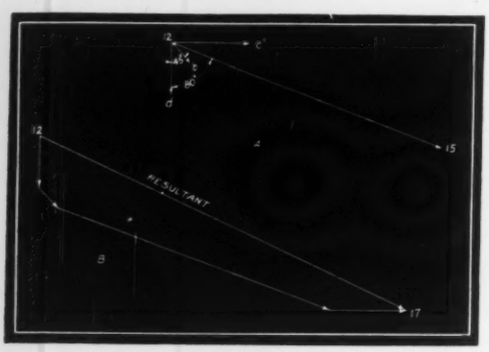
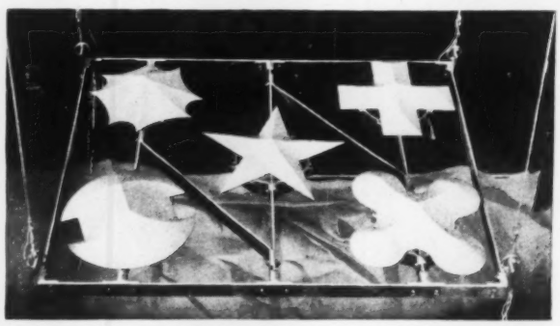


Fig. 6—Illustration of some of the points in the process of developing Fig. 4

This method of combining bending moments is not limited to cases where the beam is of circular section. When used with a beam of any other section it is of still greater value. The rectangular moment of inertia, section modulus, and therefore the maximum fiber stress in a beam of any section other than a circle depends upon the angular position of the neutral axis with respect to the section outline. The neutral axis is perpendicular to the plane of the bending moment. Since the direction of the plane of the resultant bending moment at any section is given in Fig. 4, it follows that the angular position of the neutral axis also is known. Calculating the section modulus about this axis and substituting this and the maximum moment in the beam formula gives the maximum stress with a minimum amount of work.

Sand Used To Determine Stresses

BY BURYING small disks of different shapes in sand and lifting them with their individual loads, Dr. A. Nadai, research engineer, Westinghouse Electric & Mfg. Co., shows what happens inside a steel bar when it is twisted. As gravity causes the excess sand to fall from each disk, it is seen that the remaining portion assumes a shape exactly like a pattern of "slips," the slope of which represents the distribution of torsional stresses in a shaft represented by the cross section disk. Steel flows like soft wax when placed under heavy stress, and takes a definite pattern regularly, depending on the shape of a cross section of the specimen under observation.



Method of determining stresses inside a steel bar when it is twisted by the use of grains of sand

Many branches of science, engineering and manufacturing utilize the behavior of metals as they deform plastically. Such knowledge is of value in the rolling of metal sheets, the forging of large pieces from ingots into new shapes and in many other operations, and it is essential that characteristics be known so these processes may be controlled more accurately.

Photoelastic Testing Gains Impetus

DEVELOPMENTS in the photoelastic method of studying stress distribution are providing engineers with a more effective tool in observing by the eye what actually takes place in the loading of parts. Moreover, the tests may be photographed progressively as moving pictures, recording the stress concentration arising from holes, grooves, sharp curves, etc.

THE value of data obtained by photoelastic tests is obvious and readily indicates the reason why this method is gaining popularity. MACHINE DESIGN discussed the subject in a series of articles last year; since then several interesting papers have been contributed by the applied mechanics division of the American Society of Mechanical Engineers, bringing out further progress in this manner of conducting tests. One of the developments is kinematography in photoelasticity discussed by Max M. Frocht; another deals with an investigation of celluloid as a medium, and a third covers a study of shearing stresses in keys and keyways.

Describes Apparatus Used in Tests

The apparatus used in the tests described by Dr. Frocht included a polariscope, straining frame and a motion picture camera. The loading, except in impact, was continuous and uniformly increasing, and was obtained by connecting a rubber hose to a nearby faucet and allowing a steady stream of water to fall into a large bucket suspended from the lever of the straining frame. Loading by means of flowing water has decided merits over deadweights. The engineer conducting the test can sit at the screen and leisurely watch the fringe formation as the load increases. This can be repeated as many times as necessary in order to determine the fringe order for any particular model. All pictures except some in impact were taken at the rate of 16 per second, this being the fixed speed of the DeVry camera which was used throughout the work. The models were all of bakelite and were annealed by the author's method. Monochromatic light was obtained from a mercury-vapor lamp and the use of a No. 77 Wratten filter.

Moving pictures obtained by the equipment showed the stress fluctuations during impact, and from these the increase of stress in pure bending and the time of stress oscillation were determined, the latter being in good agreement with theory.

The foregoing, while but a brief abstract, shows the nature of this new process. Although bakelite was used as the medium for the test, it is interesting to consider the paper by R. H. G. Edmonds and B. T. McMinn on celluloid as a medium for photoelastic investigation. It is one of the most common materials used because of its many suitable characteristics, being readily machined and worked into complicated shapes and models. The low modulus of elasticity permits large strains with moderate loading.

Because of the difference of opinion of investigators as to the reliability of celluloid, the authors ran a series of tests. Summarizing results they state that age seems to have a bearing on the physical properties of celluloid. Undesirable characteristics were much more marked in the newly made material. Results of photoelastic tests reported in the paper lead to the conclusion that, within the range of tests, photoelastic color in celluloid models is proportional to stress, but is not strictly proportional to strain. The photoelastic method applied to celluloid models may be expected to yield satisfactory results where proportionality of stress and strain have no critical bearing on the problem.

Keys and Keyways Are Studied

A paper on photoelastic study of shearing stresses in keys and keyways by A. G. Solakian and George B. Karelitz describes a pertinent application. The design of a key fitting into a keyway in order to transmit a given torque is based more or less on empirical formulas or standard practice. The photoelastic method is by far the most convenient and direct for observing stresses in cases such as this.

From the tests conducted by these engineers it was proved that heavy stress concentrations occurred of the order of 4 to 1 and 5 to 1 at the corners of the keyways and at points where the edges of the shaft and the hub bear against the key. As a result, cutting in of a key may be expected and often is observed, As to the concentration of the re-entrant angle of the keyway, the increased stress is of no particular harm when the torque is steady, but it is dangerous with a variable load, as cracks may occur.

Weight Distribution Controls Design of Massive Equipment

By James F. Wright

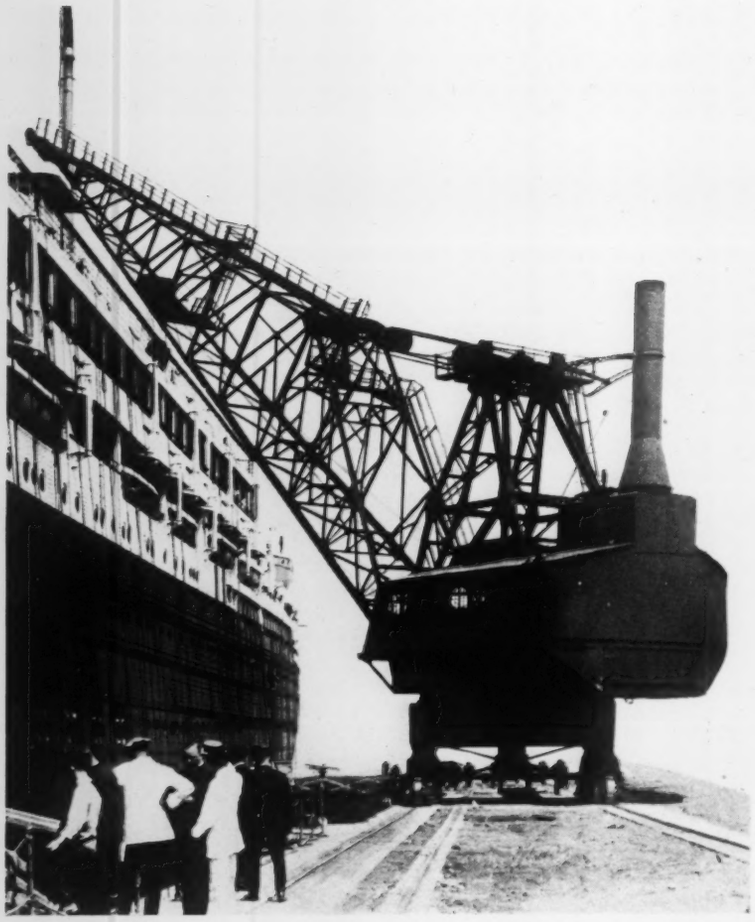


Fig. 1—General view of unit indicates immense proportions

IN THE design of a large machine such as a locomotive jib crane the engineer usually is more concerned with structural strength, accessibility and proper weight distribution than with other types of design problems. Liberal amounts of space are available as a general rule and operating conditions are not exacting. Such was not the case, however, in the development of a special unit of this type which is claimed to be the largest in the world and has a lifting capacity of 50 tons at a radius of 90 feet. The unusual capacity and special operating conditions of this crane, shown in Fig. 1, necessitated novel designs for certain parts, particularly the travel mechanisms and the truck arrangement.

Designed to operate on two-100 pound rails spaced twenty feet apart center to center on a straight track, the machine must be capable of passing around a right or left-hand curve of about 76 feet radius measured at the inside rail. Numerous difficulties were presented by this requirement, as will be realized by study of the diagram in Fig. 2. This shows the change in position of the center of the machine when passing around a curve as compared with the normal center when traveling on straight track.

In view of the enormous weight of the crane, roughly 600 tons when loaded, thirty-two wheels are required, eight at each corner, to distribute the load evenly over the track foundation. The load on each of the eight wheels on the corners, Fig. 3, always is equal, each corner reaction being distributed through a system of equalizer beams and two wheel trucks. These equalizer beams and trucks are arranged to swivel, for free action on the curves, and in order to keep the center of gravity of the machine as low as possible the truck equalizers are underhung.

To propel the unit satisfactorily under any operating condition, it was necessary to provide positive drive for one-half the wheels on each corner

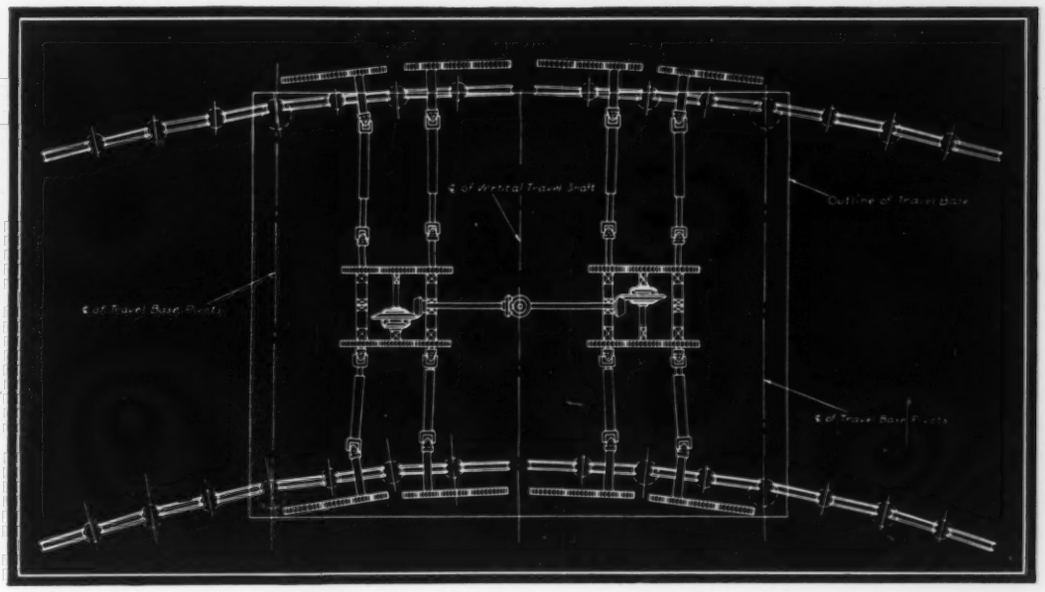


Fig. 2 — Diagram of track layout on curve illustrating the necessity for providing extreme flexibility in the drive and truck arrangement. Note the swing of the travel base toward inside rail

truck, power being derived from an engine mounted on the revolving superstructure and thence through the vertical shaft at the center.

As will be noted from Fig. 2, the four wheels on each corner that are driven are those nearest the center of the machine, in order to hold the length of the longitudinal driving shaft to a minimum. The axle of each driven wheel is extended beyond the truck and drive gears are mounted on the extensions. Each pair of gears on a truck is connected by an idler in the center of the truck.

Flexibility of the unit, allowing for swiveling of the trucks and variations in track elevation, is provided by designing the driving cross shafts, Fig. 2, in three sections. The outer sections are mounted on the trucks and swivel with them; the inner sections are mounted on the travel base, near the center, and move with the base; and the middle sections are connected to the others by universal couplings.

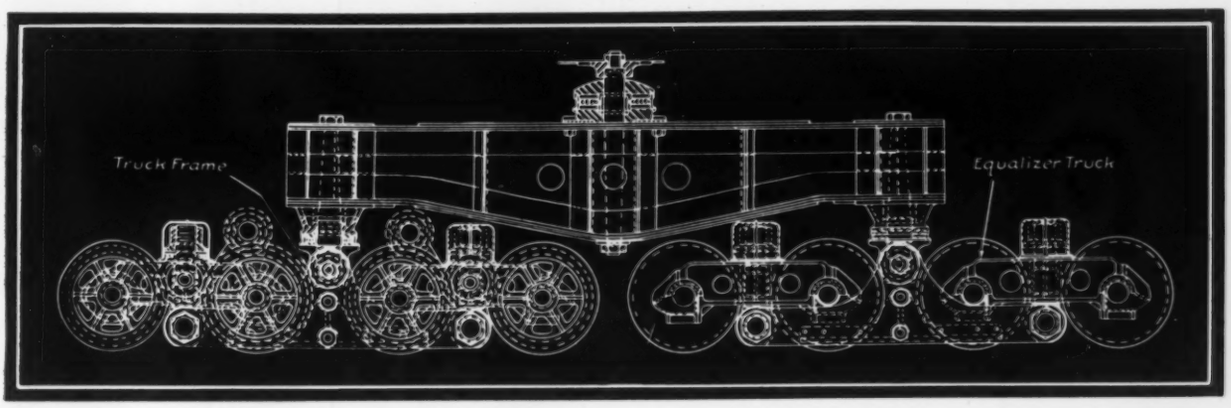
To transmit the differential speeds required on the curves, each truck is driven by a separate cross shaft unit, and to permit variations in the relative positions of the driven trucks and travel base, provision is made for a telescoping action of at least 19 inches in each of these shafts. This is accomplished by making the two sections of each shaft compound members.

The roller circle on which the superstructure of the crane rotates is, in effect, a roller bearing comprising an upper roller path attached to the revolving frame and a lower roller path, with rotating rack gear cast integral, attached to the travel base and the roller cage assembly. Forty bevel rollers are used, 15 inches outside diameter and 7½ inches face, running on machined bevel surfaces to afford full roller contact without differential action.

Power for rotation of the crane is obtained from a separate engine mounted on the revolving superstructure. This power is transmitted to the rack gear by two manganese steel pinions mounted on vertical shafts extending through the rotating frame and running in bronze bushed steel castings connected rigidly to the frame.

Most of the gears employed in the complete unit have 20-degree involute stub teeth, the principal exceptions being the rack gear and pinions. These have 20-degree involute standard teeth with extra clearance.

Fig. 3—Each corner truck has eight wheels mounted on equalizers. Half the wheels are driven



Editorial

Shop Restrictions Increase Opportunities for Design Ingenuity

READERS of the article beginning on page 29, dealing with the relations of designers and shop superintendents, will recognize the timely significance of the subject. Never in the life of the present generation has teamwork between the design and production department been as heavily freighted with opportunities for economy.

Few companies have been able to purchase improved equipment in recent months. Much of the machinery of manufacture is obsolete. Until it is easier to finance replacements, many machinery companies must do the best they can with existing facilities.

This means greater responsibility and increased opportunity for those engaged in design. It places a premium on ingenuity for adapting design to the abilities of the production department. Likewise it is a challenge to the resourcefulness of the shop personnel.

Department heads in many organizations are alive to this situation. In one case excellent co-operation between the design and production staffs is enabling a motor car manufacturer to perform an important share of the work on his 1932 models on machines originally purchased for special jobs. It involved changes in the shop equipment and considerable modification in the details of design, but the necessity of setting aside a large outlay for new equipment was avoided.

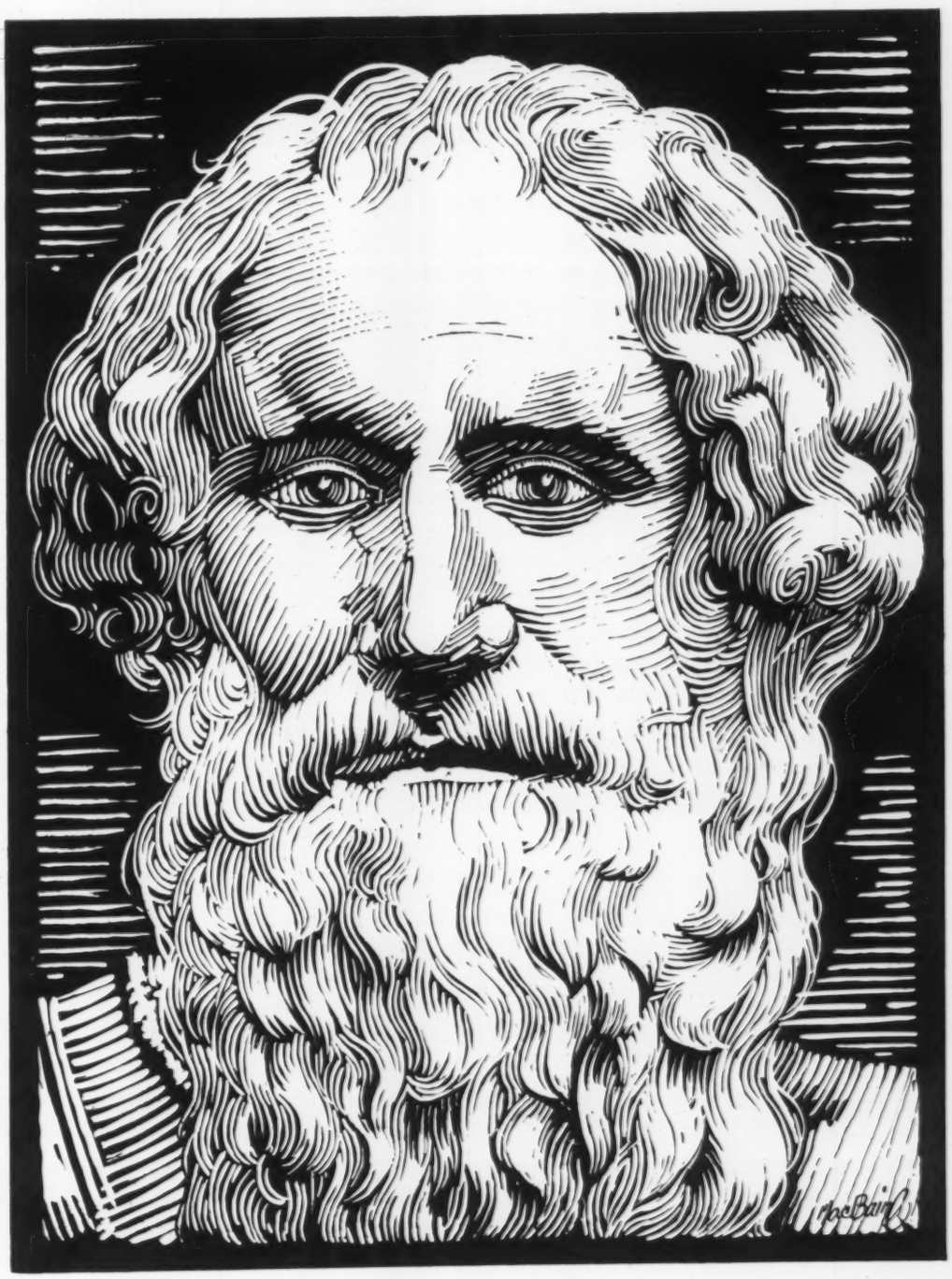
We hold no brief for the unnecessary retention of obsolete equipment. Ordinarily it is a mistake. But in this emergency many manufacturers are forced to do with what they have. This is a temporary situation in which an alert, resourceful engineering staff can be of great service.

Reduction in Working Hours—and the Designer

PROPOSALS to limit the number of working hours have been rife during past months, and probably will continue. Even apart from the pressure resulting from present economic conditions, the tendency toward a shorter work day has been marked since the World war.

In considering wage adjustments in the light of possible changes in the number of hours per day or week, the management of machinery companies should always keep in mind the fact that the engineer in charge of design does not work by the clock. His task is not completed at the end of the working day. Much of the really creative part of his work is conceived during his so-called hours of leisure.

Good engineering talent should be paid for on the basis of service rendered. Its value cannot be measured in hours per day, week or month.



Archimedes

Master Designers

Archimedes

INHERENT inquisitiveness as applied to every-day phenomena by mechanically minded scientists has been the starting point of most great discoveries. Stories of Newton and the falling apple and of Archimedes and his discovery while bathing of the principle of specific gravity are familiar to every one. At the time, this great geometer was seeking a method of determining the percentage of gold in the king's crown. Continued investigation led to the founding of the entire science of hydrostatics.

ARCHIMEDES, the greatest scientist of the Alexandrian age, appropriately called "the first Yankee," combined practice and theory, experiment and inference in a thoroughly modern way. He possessed to a high degree the inventive genius which discovers new provinces of inquiry and finds new points of view for old and familiar objects. Mechanical models were used by him for solving mathematical problems, but he considered his ingenious inventions as "diversions of geometry at play."

PROBABLY the best known of his mechanical contrivances is the water screw which he devised to raise water for irrigation, for pumping from mines, etc. Personally he considered his greatest work the circumscribing of a cylinder about a sphere. Of more general value, however, was the development of the principal of balance of weights in mechanics. Nearly 1800 years elapsed after his discoveries before further appreciable progress was made in theoretical mechanics.

BORN in Syracuse, Sicily, in 287 B. C., Archimedes applied his genius to the protection of his city during a Roman attack. He developed catapults equally serviceable at long and short range, and cranes that grappled ships, lifted them, and let them smash. His ability so handicapped and frightened the Romans that they turned from attack to siege. During the subsequent sack of the city, Archimedes, intent upon the solution of an involved problem, was killed by a Roman soldier.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Determining Horsepower of Gears

To the Editor:

IN ORDER to eliminate much of the tedious calculation necessary to determine the proper gears to transmit a given horsepower, the accompanying nomograph (page 52) was prepared. Formulas used in its preparation are:

$$A = \frac{0.15\sqrt{V} + 9}{P}$$

where

A = Width of gear face
V = Velocity in feet per minute
P = Diameter pitch

and

$$HP = \frac{SYAV}{P33000}$$

where

HP = Horsepower
S = Allowable unit stress at a given velocity
Y = Outline factor
A = Width of gear face
V = Velocity in feet per minute

and

$$V = 0.262\ DR$$

where

V = Velocity in feet per minute
D = Pitch diameter of gear
R = Revolutions per minute

Generally the revolutions per minute and pitch diameter are determined by the gear train before it is necessary to determine the proper pitch and width of gear to transmit the given horsepower. Therefore, the velocity next is determined by use of the velocity chart, lower right. This is done by passing a line through the diameter and RPM to the velocity line. If the diameter on the left-hand side of the diameter line is used the corresponding value of velocity appears on the left-hand side of the velocity line. If the diameter on the right-hand side of the diameter line is used the corresponding velocity value is on the right-hand side of the velocity line.

The pitch and width are next chosen arbitrarily, or one may be chosen arbitrarily and the other found by use of the small chart in the upper right-hand corner. An example is shown.

Another method which now is used generally, is to select the value of A somewhere between $3\pi/P$ and $4\pi/P$. If this method is employed the value of $A = 3.5\pi/P$ is shown opposite the pitches in the main chart. Therefore, the intersecting line passing through the line A should also pass near to the chosen pitch. A number of trials may be necessary to get the proper combinations.

It ordinarily will not be necessary to compute values of S for given velocities for 1020 steel or nickel and Ni-chrome. Other values that are required may be interpolated. If multiples of ten times or 1/10 these values are used the values of HP must be chosen accordingly. For example the values of S for given velocities of nickel and Ni-chrome steels are ten times those indicated on the left-hand side of the S line and the values of HP for these steels are shown on the right-hand side of the HP line as ten times the values on the left-hand side of the HP line.

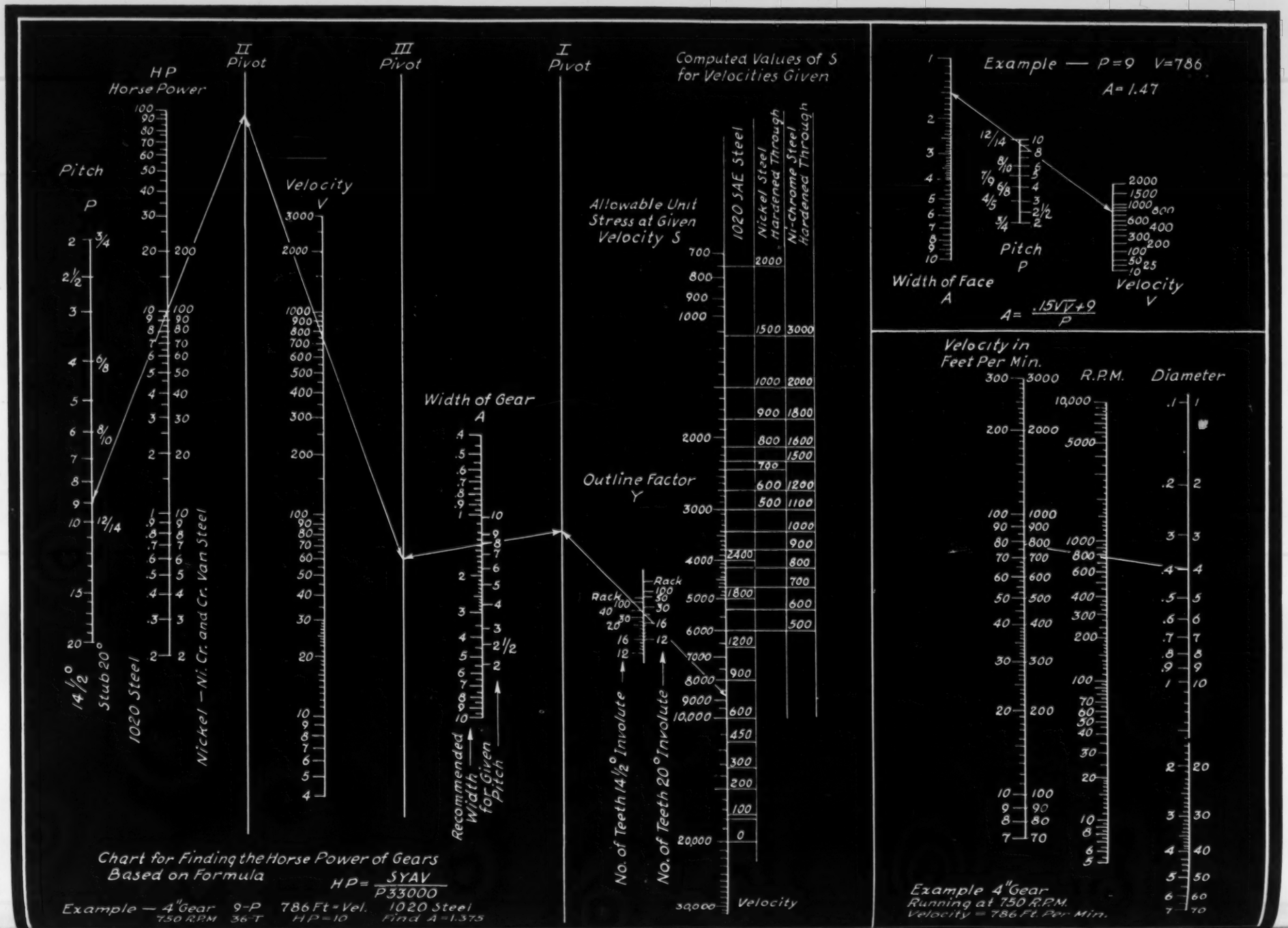
Example: A 4-inch pitch diameter 14½ degree involute gear running at 750 RPM, to deliver 10 HP, (the gear to be made of 1020 case hardened for wear). Connect, on the lower right hand nomograph, the diameter, 4, with the RPM, 750 and note the intersection on velocity line 786. Choose 9 pitch arbitrarily. Connect velocity 786 on line S with 36 ($4 \times 9 = 36$ teeth) on line Y and note intersection on pivot No. 1. Then connect 9 pitch on P line with 10 on HP line and note intersection on pivot No. 2, connect this point with velocity on V line and note intersection on pivot No. 3, then connect this point with that found on pivot No. 1. The line intersects A at 1.375 and indicates that the proper pitch is between 8 and 9. Either pitch would do equally well or 8/10-20 degree involute gear could be used if extra strength is desired. The width of the gear therefore would be 1.375 inches and the pitch 8 or 9.

—P. R. GUIRL,
Rockford, Ill.

Analyzing Stress in Pulleys

To the Editor:

IN 1898 C. H. Franklin carried some static tests on pulleys to destruction. He noted that the spokes near the tight side of the belt fractured first and suggested that in designing pulleys it be assumed that the entire torque be transmitted by only half of the spokes in the wheel—a reasonable assumption. The fore-


HP
Horse Power
II
Pivot
III
Pivot
I
Pivot
Computed Values of S
for Velocities Given
Pitch
P
Velocity
V
Allowable Unit
Stress at Given
Velocity S
1020 SAE Steel
Nickel Steel
Hardened Through
Ni-Chrome Steel
Hardened Through
Width of Gear
A
Outline Factor
Y
Rack
No. of Teeth 14½° Involute
No. of Teeth 20° Involute
Recommended
Width
for Given
Pitch
Velocity
14½° Stub 20°
1020 Steel
Nickel — Ni. Cr. and Cr. Van Steel
Chart for Finding the Horse Power of Gears
Based on Formula
HP = SYAV / P33000
Example — 4" Gear 9-P 786 Ft = Vel. 1020 Steel
750 R.P.M. 36-T HP = 10 Find A = 1.375
Example — P = 9 V = 786
A = 1.47
Width of Face
A
Pitch
P
Velocity
V
A = .15√V + 9 / P
Velocity in
Feet Per Min.
R.P.M.
Diameter
Example 4" Gear
Running at 750 R.P.M.
Velocity = 786 Ft. Per Min.

going statement is covered by the formula:

$$fZ = M = (T_1 - T_2)\ D/n = 2T/n$$

where

f = allowable fiber stress in spoke
Z = required section modulus of spoke at hub
M = bending moment resisted by each spoke—inch pounds
T_1 = total tension, tight side of belt—pounds
T_2 = total tension, loose side of belt—pounds
D = pulley diameter in inches
n = number of spokes in pulley
T = torque (in-lb) transmitted by pulley shaft

The section modulus of spoke section near the rim usually is taken as half that required at the hub.

Mr. Lieutweiler analyzed many pulleys with the aid of the formula given and found that the stress in the spokes of cast iron pulleys when operating at their rated load varied between 200 and 1500 pounds per square inch. With modern iron a modulus of rupture of 30,000 pounds per square inch is not unusual. Obviously the usual run of pulleys have a large factor of safety—much larger than necessary.

In many cases the weight and cost of the extra metal making up this high factor of safety is of no importance, but when the wheel must frequently be stopped or reversed, or the pulley is used on a machine being built in large quantities, it is advantageous to use as little metal as possible. The question now arises as to how high cast iron (or other metals) can be stressed safely when used in pulley arms. Perhaps some reader has accurate data on this subject.

—E. H. HAGEN,
Appleton, Wis.

Shaft Deflection and Bearing Design

To the Editor:

THE first paragraph of H. F. Shepherd's article in the January issue attracted me as much as any other, especially the statement of his first classification of shafts:

> "Shafts in which combined stresses are required to be below the fatigue limit. The resulting deflections are tolerated."

An elaboration of the thought in this statement may not fall strictly within the scope of the subject, yet it should not be out of place.

It is surprising how many engineers and designers have only a vague understanding of combined stresses and how to take care of them in design. They understand a torque moment or a bending moment alone, but when both exist at the same time they think, apparently, that it is either unnecessary or difficult to consider the combined effect. It may be that some are confused because many texts explain that the stresses must be combined according to one of the "theories of strength" without pointing out clearly which one to use or how to use it. Since the Maximum Shear Theory agrees quite closely with most test results, it is favored at present over other theories, and it has the advantage of giving a somewhat more conservative design. By this theory the effect of a bending moment M_B and a torque M_T at any section of a shaft may be considered by using the following simple formula which yields the proper shaft diameter:

$$d = \sqrt[3]{\frac{10.2}{S}\ \sqrt{M_B^2 + M_T^2}}$$

S is the allowable working stress in tension based on the fatigue limit of the steel.

An additional thought might be added in connection with the author's discussion of double row bearings. When tapered roller bearings are employed with no preloading, it is customary —as the author points out—to adjust them so that there is an allowable end play of about 0.005-inch. In most cases this play will be taken up only partially, or not at all, during operation. Since the angularity of the rollers averages about 15 degrees, there is a vertical play in the neighborhood of 0.0005 to 0.001 inch. Therefore, as the spacing of the inside bearings usually will be at least six or eight times that of the two rows of rollers, the shaft may deflect 0.002 or 0.004 inch or more at the center before the outside rows of rollers restrict the deflection. Consequently, only a small straightening force, or none whatever, may be added to the $\frac{1}{2}\ W$ load on the inner rows of rollers. Obviously, the closer the bearing spacing in any given application, the smaller the shaft deflection. The condition also may help to explain the continuance of similar applications of tapered roller bearings.

—J. W. BAUGHER, JR.
Pittsburgh.

Let's Respect Unfinished Drawings

To the Editor:

MANY apparently intelligent executives have what seems to me to be one unpardonable sin, the thoughtless habit of making free hand sketches on a drawing partly finished on the drafting board. Despite signs, suggestions or entreaties some men seem to think that this is the logical place to make sketches of anything and everything, whether it pertains to the development work at hand or not.

The president or the general manager will get an idea and will come rushing into the engineering department and before he can be stopped will have a scrawly sketch on the designer's drawing.

It is high time that executives co-operated with designers in their effort to produce first-class drawings by making their sketches in places where they will not do so much harm.

—JAMES M. MURPHY,
Lakewood, O.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

FOR distinguished scientific achievement in the field of heating, ventilating and air conditioning, Willis H. Carrier recently was presented with the F. Paul Anderson gold medal. He is chairman of the board, Carrier Corp., Newark, N. J., and is recognized as the father of the science of modern air conditioning, resulting from his mathematical investigations and development of machinery.

Born in Angola, N. Y., Nov. 26, 1876, Mr. Carrier was graduated in mechanical engineering at Cornell university in 1901. Subsequently he was employed as research engineer with the Buffalo Forge Co., and in 1906 was made chief engineer. In 1915, with J. Irvine Lyle and others, Carrier Engineering Corp. was founded with Mr. Carrier as president.

As part of his work in the development and design of air conditioning equipment, Mr. Carrier presented to the American Society of Mechanical Engineers, in 1911, his rational psychrometric formulae, a study which constitutes the foundation upon which the science of air conditioning is built. As the science has grown and expanded, Mr. Carrier has contributed consistently to its development. He had much to do with the perfection of the centrifugal fan and the centrifugal pump. More recent among his many accomplishments has been the invention of a centrifugal refrigerating machine.

HUMANITY owes much to Dr. William David Coolidge, and engineering, particularly is indebted to him. It was he who developed ductile metallic tungsten which now is used for practically all filaments of incandescent lamps, in vacuum tubes and many other applications including contact points and electrical apparatus. For this and other noted developments which have materialized as a result of his persistent research and experiments, Dr. Coolidge recently was presented the Washington Award for 1932.

This eminent engineer was born in Hudson, Mass., October 23, 1873. In 1896 he was graduated from the Massachusetts Institute of Technology with a bachelor of science degree, after which he went to Germany and received his Ph.D. at the University of Leipzig in 1899. Returning to the United States, Dr. Coolidge joined the teaching staff of the Massachusetts Institute of Technology, serving first as assistant in physics, then as instructor in physical chemistry and finally as assistant professor of physico-chemical research. In 1905 he became a member of the staff of the General Electric Research Laboratory under Dr. Whitney and in 1908 was made an assistant director of that organization, a position which he occupied until 1928 when he was made associate director.

Dr. Coolidge received the Rumford Medal for his invention of ductile tungsten in 1914, and subsequently has been awarded the Howard N. Potts medal, the Lewis Edward Levy gold medal, the gold medal of the American College of Radiology, the Hughes medal from the London Royal society, and the Edison medal. He holds the honorary degree of doctor of science from Union college and Lehigh university.

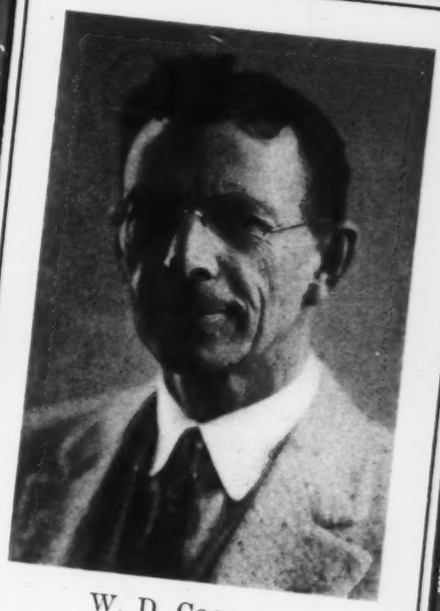
THERE is inspiration in the career of Harold S. Vance who recently became president of Rockne Motors Corp., Studebaker's newest subsidiary. His record is characterized by his rise from apprentice at the age of 15 in the Studebaker factory at Detroit to his present post. Mr. Vance's ability in mechanical design was one of the chief factors in his climb from one job to another in the organization.

Except for a period during the World war when he accepted an important executive position with Bethlehem Steel Corp., he has been affiliated with the automobile industry since 1910. From apprentice he advanced rapidly to mechanic, storekeeper, general storekeeper and supervisor of specifications and stores. He later gained experience in manufacturing and sales, and at the age of 35 was appointed vice president in charge of manufacturing of the Studebaker Corp. Mr. Vance is continuing that capacity, simultaneously with his duties as president of Rockne.

CASTING-MINDED, Arthur Simonson, Falk Corp., Milwaukee, has contributed a great deal of his time, energy and thought to the upbuilding of the foundry industry. He has taken

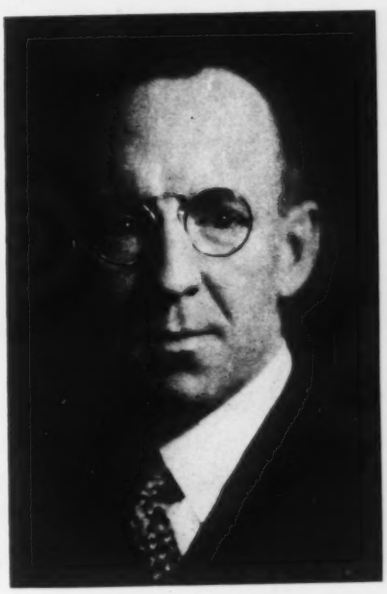
Leaders in Design, Engineering and Research

W. H. CARRIER



W. D. COOLIDGE

HAROLD S. VANCE



ARTHUR SIMONSON

an active part in the affairs of the Steel Founder's Society of America of which he recently was elected president.

Mr. Simonson was born in England, educated in the public schools and at Sheffield Technical school. He first was employed at Edgar Allen & Co. Ltd., Sheffield, England, working under the supervision of Alexander Tropenas, inventor of the side blow converter process for making steel castings. In 1900 Mr. Simonson came to the United States, spending several years installing converters in various plants throughout the country.

For the next six years he was superintendent of foundries for William Wharton Jr. & Co., Philadelphia. In 1909 he joined the Falk Corp., taking up his first work in the operating department. The post of sales manager followed in 1916 and in 1927 he was elected vice president of the company. In these various capacities he has been associated closely with activities in design in which steel castings have played an important part.

* * *

W. A. Rosenberger recently was appointed chief engineer of Pangborn Corp., Hagerstown, Md. For 20 years he has specialized in blast cleaning and dust collecting problems and is the designer of numerous unique machines in this classification. Mr. Rosenberger has been a frequent contributor to MACHINE DESIGN.

* * *

Daniel F. Ritchie has accepted a position as designing engineer with La Plant Choate Mfg. Co., Cedar Rapids, Iowa. He formerly was affiliated with Allis-Chalmers Mfg. Co. at Springfield, Ill.

* * *

Alois Hauser, assistant works manager in charge of engineering, both for the bearings plants and steel mills of Timken Roller Bearing Co., Canton, O., has resigned, having held that position since 1920.

* * *

Dr. Karl Arnstein of the Goodyear Zeppelin works, Akron, O., designer of the dirigible U. S. S. AKRON has returned from a trip through Europe. During his trip he visited in Germany at Friedrichshafen where the German zeppelin L. Z. 129 is under construction.

* * *

W. S. Lee, Charlotte, N. C. recently was elected president of the American Engineering council at its annual meeting in Washington. Other officers elected include: L. B. Stillwell, New York, re-elected vice president; R. C. Marshall Jr., New York, vice president, and Farley Osgood, treasurer.

* * *

R. E. Peterson, manager mechanical division, research laboratories, Westinghouse Electric Mfg. Co., East Pittsburgh, Pa., and T. S. Fuller, research laboratories, General Electric Co., Schenectady, N. Y., have been appointed members of the American Society for Testing Materials committee on fatigue of metals.

* * *

Alfred Tucking, former designer for the Packard Motor Car Co., Detroit, is now employed by the Chrysler Corp., Highland Park, Mich., as a mathematician.

* * *

Eric Wisbrun, formerly research engineer, Perfect Circle Co., Newcastle, Ind., has been placed in charge of the chemical and physical laboratory of the Liberty Foundries Co., Rockford, Ill.

* * *

Harry A. Kidder, superintendent of motive power, Interborough Rapid Transit Co., New York, has been elected president for 1932 of the United Engineering Trustees, New York, joint agency of the four founder engineering societies. Dr. Alfred D. Flynn, director of the Engineering Foundation, continues as secretary.

* * *

H. J. French has been placed in charge of the development work in steel and iron at the research department of International Nickel Co. Inc., New York. Since 1929 he has been a member of the research staff of the company's laboratory in Bayonne, N. J.

* * *

J. R. Rue, managing engineer of the motor department of General Electric Co., Pittsfield, Mass., plant, has been assigned to special work at Schenectady. He has been at Pittsfield since 1912. K. R. Van Tassel, designing engineer of the same department, has been transferred to the Fort Wayne, Ind., works.

* * *

George H. Bucher recently was elected vice president and general manager of Westinghouse Electric International Co. He joined the Westinghouse organization September 1, 1909, after having been graduated from the Pratt Institute in Brooklyn in both machine design and electrical engineering. He was transferred from the graduate student course at East Pittsburgh to the export department in New York January 20, 1911.

* * *

A. W. Thompson has been appointed vice president in charge of manufacturing of Fairbanks, Morse & Co., Milwaukee, succeeding W. C. Heath who resigned recently to become vice president in charge of research engineering, A. O. Smith Corp., Milwaukee. Prior to joining the Fairbanks, Morse Co. in 1920, Mr. Thompson was with General Electric for 10 years, having had charge of design and development at the Erie works of that company.

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

The Fundamentals of Design

The Elements of Machine Design, by Wilfrid Collins; cloth, 5½ x 8½ inches, 248 pages; published by Oxford University Press, New York and London, and supplied by MACHINE DESIGN for $5.00 plus 15 cents postage.

As the title of the book implies, the author has compiled a volume of elementary and fundamental data to function as a series of notes which the reader can amplify by his own efforts at analysis, or synthesis, as well as by wide reading of more detailed works. Obviously, the volume is intended for the student designer of machines and will be found useful to those who are building a foundation of knowledge in this field of engineering.

The first four chapters deal with materials, processing, mathematical analysis of internal stresses, and the possible effects of the conditions to which machine parts will be subjected. Different types of fastenings are discussed in succeeding order, bearings and various forms of transmitting power are treated, and chapters 10 and 11 indicate methods of analysis and comparison of existing machine parts, and the evolution of new designs. The author assumes that the reader has a knowledge of the principles of mechanism and theory of elasticity.

□ □ □

Temperature Effect on Metals

Symposium on the Effect of Temperature on the Properties of Metals; cloth, 6 x 9 inches, 825 pages; published jointly by the American Society of Mechanical Engineers, New York, and American Society for Testing Materials, Philadelphia; and supplied by MACHINE DESIGN for $6.00 plus 15 cents postage. In lots of more than nine copies a special price is offered.

Data dealing with temperature effect on metallic materials are treated in a symposium recently made available in book form. This study of a subject in which the designer of machinery has much in common with the metallurgist will serve to strengthen the already close liaison between these two technical divisions.

The 27 papers in the book are largely compilations of data from many sources, domestic and foreign, but have been handled by experts qualified to appraise and interpret the data of others as well as their own. Two general sections make up the volume, one covering engineering trends and requirements for metals at high and low temperatures; the other discussing properties of available metals for high and low temperature service.

An effort has been made to make the book a ready reference volume, both in respect to specific and general topics.

□ □ □

Balancing Problems Discussed

The Balancing of Machinery, by C. Norman Fletcher; 172 pages, 5½ x 8½ inches; published by Emmott & Co. Ltd., London, England; and supplied by MACHINE DESIGN for $2.40 plus 15 cents postage.

With the introduction of high rotational speeds in the design of machinery the engineer now is confronted with problems of accurate balancing. In view of this and because of the dearth of published material on this subject, Mr. Fletcher's book fills an acute need.

Topics treated which will be of assistance to engineers engaged in design include general principles of balance, static balancing equipment, dynamic balancing equipment, influence of speed on the general principles of balance, the balancing of reciprocating masses and complete assemblies, and the practical correction of unbalance.

The problem of balancing of machinery is considered theoretically, and each form of balance is dealt with separately with discussion indicating how it may be examined and corrected.

□ □ □

Study of Noise and Vibration

Noise and Vibration Engineering, by Stephen E. Slocum; cloth, 6 x 9 inches, 171 pages; published by D. Van Nostrand Co. Inc., New York; and supplied by MACHINE DESIGN for $2.75 plus 15 cents postage.

As one of the pioneer works on the subject of noise and vibration and their various aspects in engineering, commercial, industrial and civic lines, this book covers details which will aid engineers coping with problems involving these two factors. It presents detailed data on principles, measurements, insulation tests and practical methods of solving specific problems.

The author has included a chapter discussing methods of damping vibration at the source, compression pad insulation, spring tension, etc.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

MECHANICAL ability and the capacity to get the most out of it constitute one of the major topics under discussion today. To this discussion Harry L. Horning, former president of the Society of Automotive Engineers, contributes several points worthy of profound consideration. Those men in technical pursuits, he says, represent one of the best types civilization has created. Conceding this, management has its greatest opportunity is making conditions such that dormant possibilities can be developed and the greatest returns realized from investment in these men.

Concurring with what often has been expressed in MACHINE DESIGN, Mr. Horning declares that technical men should be creative; sometimes they are brought down to the level of clerks by routine work and the domination of standards and rules. The engineer often is kept so close to office routine that he cannot see with the eyes of the user or feel his mental twist. By passing through too many hands before it reaches him, the picture which the technical man gets is sometimes in the form of opinions of careless observers. Nothing takes keener analysis than scrutiny of information brought from the field.

Some turnover Mr. Horning considers necessary to counteract the tendency for all human activities to slow down. Where life is easy, men stagnate and character decays. The average man, he says, is living up to about one-fourth of his possibilities. This is a startling fact which should stimulate greater attention to the study of human nature and result in more thorough understanding of the man and his proper place in industry.

* * *

Locomotive Completes 100,000 Mile Test

PROBABLY the most comprehensive test to determine the success of an application of antifriction bearings on railway locomotives recently was completed after a 100,000 mile run. Engineers over the entire country have watched the performance with technical curiosity. The fact that during the entire test period not a single instance of bearing trouble was recorded now indicates that the day of the completely antifrictionized locomotive is here.

This locomotive was designed by Timken Roller Bearing Co., Canton, O., to demonstrate the ability of its product for this class of service. During its test run it was operated from coast to coast under every conceivable condition of climate, terrain and trackage, hauling the heaviest freight trains and the fastest passenger trains.

A decided increase in starting efficiency was revealed by this test which shows that antifriction bearings increase locomotive tractive effect considerably when trains are started. Unassisted, this locomotive moved from rest trains that ordinarily would have required a helper to get under way.

* * *

War in Orient Produces Little Business

PRODUCERS of finished steel state they cannot detect the influence of the Sino-Japanese disturbance at Shanghai in their orders, but reports that both China and Japan are quietly seeking to place munitions and supplies are persistent.

One manufacturer in Illinois and two in Wisconsin are reported at work on tanks and other war material. It is understood that assiduous efforts have been made by both nations to obtain anti-aircraft guns, gas masks and similar supplies.

* * *

Hoover Is First Engineer To Be President

UNVEILING of a large portrait of President Hoover at the recent meeting of the United Engineering Trustees in the Engineering Societies building in New York awakens a profound thought in the minds of engineers. This was best expressed in the ceremonial address of A. H. Kidder, president of the organization, when he said: "I have the honor of unveiling and placing in the custody of the United Engineering Trustees in our Temple of Engineering, this vital and beautiful portrait in oils of the first member of our profession to be elevated to the high office of president of the United States."

President Hoover, honorary member of each of the four national engineering societies, and former president of the American Institute of Mining and Metallurgical Engineers, sat for this portrait at the suggestion of Ambrose Swasey and at the request of the four societies.

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7. Vertical Shaft Drives
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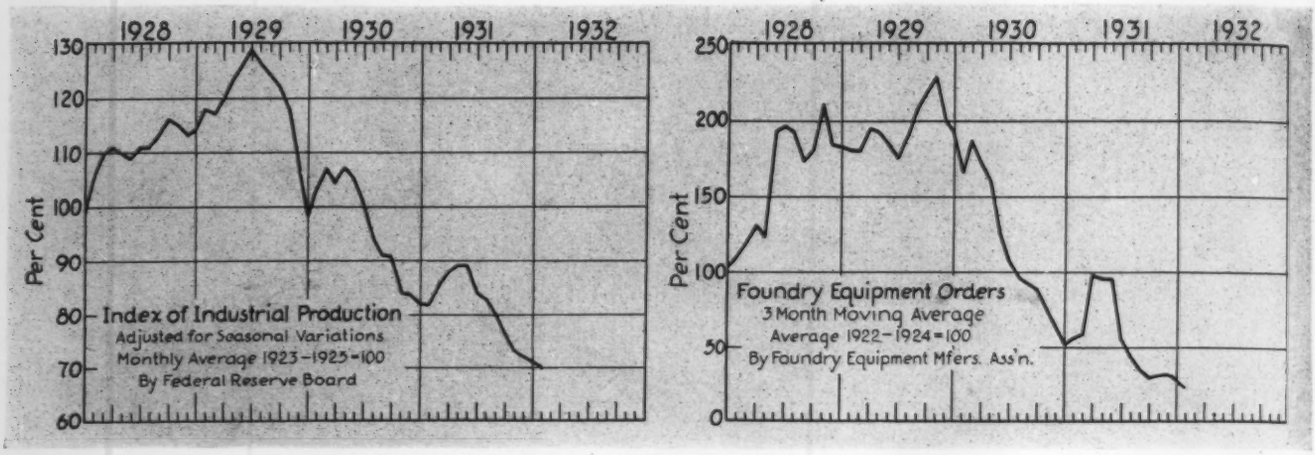
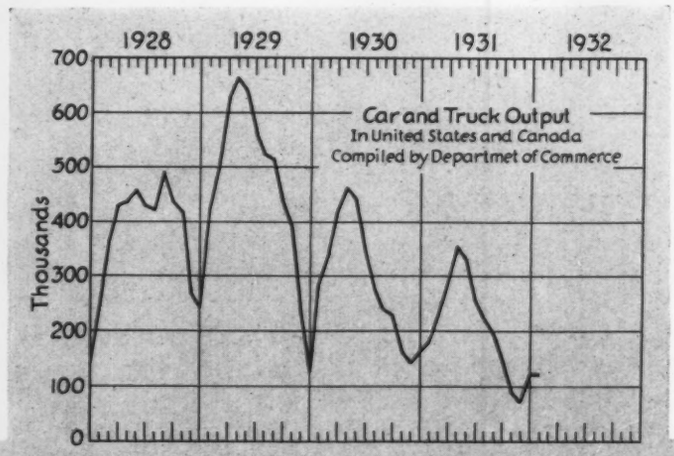


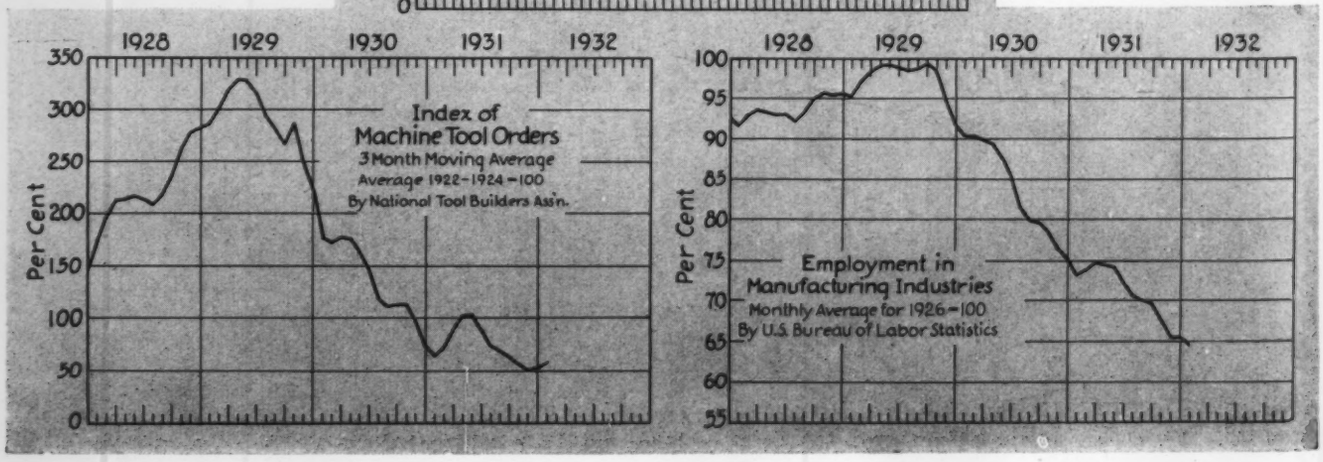
How Is Business?

WITH the acceptance of wage cuts by the railroad unions and the building trades the process of stabilizing business finally has reached the point where industrialists are beginning to warn against over-deflation. As this trend, a certain sign of convalesence, increases, so will business increase and efforts toward retarding its decline can be stopped.

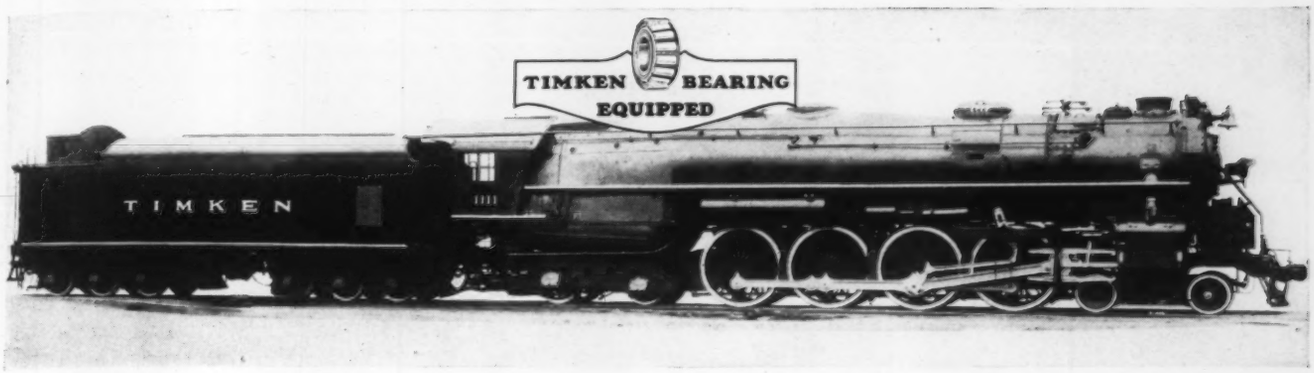
The steps being taken by the President and Congress cannot be explained as inflationary measures. These activities are designed primarily to remove the pressure that has been shoving business to new low levels. There is absolutely no reason why industrial activity, commodity prices and similar indexes should remain at levels far below the average for the past fifty years. The super-development of '29 has been adjusted. Now Congress is attempting to bring levels back to the position they should occupy in view of the long-time trend.

Henry Ford, by delaying the introduction of his new models, continues to cloud the future for many industries. When this one company opens up, its influence may prove to be the most widespread of any factor since the present slump began. It is estimated that it will take this enormous producer three months to stock his dealers completely. And there is to be added to this, 85,000 orders that have been received already. It is not difficult to imagine the influence this production will have on the situation in employment, materials, parts and machine development.





THE TIMKEN LOCOMOTIVE



100,000 miles without bearing trouble

A revolutionary accomplishment in locomotive operation

Again Timken has successfully pioneered a great forward step in anti-frictionization, and as a result, another important chapter has been added to the history of railroad development.

The Timken Locomotive was the first locomotive in the world to be completely equipped with anti-friction bearings on all axles—leading truck, driving wheels, trailer truck and tender trucks.

It was built by Timken to demonstrate the advantages of Timken Bearings in locomotive operation, and was placed in service on April 15, 1930. In January this year, the Timken Locomotive completed its official service test of 100,000 miles. This mileage was made on 14 railroads in regular passenger and freight service, and under every conceivable running condition.

Tough as locomotive operation is on bearings, the Timken Bearings in the Timken Locomotive have given no trouble whatever. No bearing repairs or replacements have been made. Railroad master mechanics and engine foremen know what this remarkable performance means. They will tell you of the tremendous savings it will effect in locomotive maintenance . . . the dependability it assures.

Equally spectacular results in hauling capacity; starting ability; speed; and fuel economy have been demonstrated, and for the first time in railroad history a locomotive has been able to handle the fastest passenger schedules and the heaviest freight trains with equal ease and efficiency.

It may seem a far cry from locomotives to machine tools, but the same exclusive combination that has enabled Timken Bearings to do what has never been done before in all railroad experience, assures better machine tool operation . . . chatter-free spindles; power-saving gear boxes and feed mechanisms; longer machine life; lower upkeep costs. That combination is Timken tapered construction, Timken positively aligned rolls and Timken-made steel—the combination that eliminates friction and carries all radial, thrust and combined loads at the same time. Specify Timken-equipped.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *Tapered Roller* BEARINGS

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

WRAPPING of annular products such as tire casings, and winding of wire coils on a ring-like core are being done by ingenious machines. Improvement of these units is continuing, as indicated by a recently granted patent which covers an arrangement, Fig. 1, for automatically adjusting a wrapping machine to accommodate any size of tire. Roland A. Labine is the inventor, and Fisk Rubber Co., Chicopee Falls, Mass., has been assigned the patent, designated No. 1,841,609.

In the machine to which the mechanism is adapted, a shuttle 28 is equipped with spindle 31 on which the roll of paper is carried. The strip of paper passes over tensioning bars 33, shown in *C* Fig. 1, as the shuttle revolves to perform the wrapping operation.

The arrangement for which the patent was granted is employed to center the tire, regardless of size, accurately with respect to the shuttle. Because of the lazy-tongs connection between upper locating rolls 37 and 95, Fig. 1*A*, through levers 86 and links 87 and 88, the shaft 85 (see view *C*) always is opposite the midpoint of the tire section when the rolls are in contact with the outer and inner peripheries of the tire. The slide composed of parallel plates 41, and on which the centering parts are carried, is mounted on upright posts 44. The permanently fixed center at the end of link 77, controls the movement of the tongs, and also is carried on one of these posts. Both arms of lever 76, *B*, being equal, and links 77 and 81 also being equal, shaft 64 always is halfway between pivot 82 and the fixed pivot. This latter pivot is located the same distance above the midplane of the shuttle as pivot 82 is below shaft 85.

Roll shafts 38 and 58 always being equidistant from the center 64, shaft 64 necessarily is opposite the center of the tire when rolls 36 and 37 are in contact with the outer periphery.

By depressing treadle 72, Fig. 1*A*, the slide is permitted to travel upwardly under the influence of a counterweight, 53, and the three-armed lever 63 (see *B*) is released for counterclockwise rotation by spring 65. Rolls 36 and 37, Fig. 1*A*, then are initially brought in contact with the outer periphery of the tire, centering it with respect to shaft 64. The slide is raised by the counterweight, separating shaft 64 from the pivot 78. Through the linkage connecting shaft 64 and fixed pivot 78 with the shaft 85, the latter rises with twice the rapidity of the slide. As soon as roll 95 commences to rise, a cam 103 releases it and under the influence of a spring the roll continues its upward movement until it strikes the inside of the tire. The slide then stops and the tire centered.

ADJUSTMENT of two rollers in a folding machine in order to change the distance between them, thereby accommodating products of different thicknesses and at the same time keeping the rollers centered with respect to the fold-

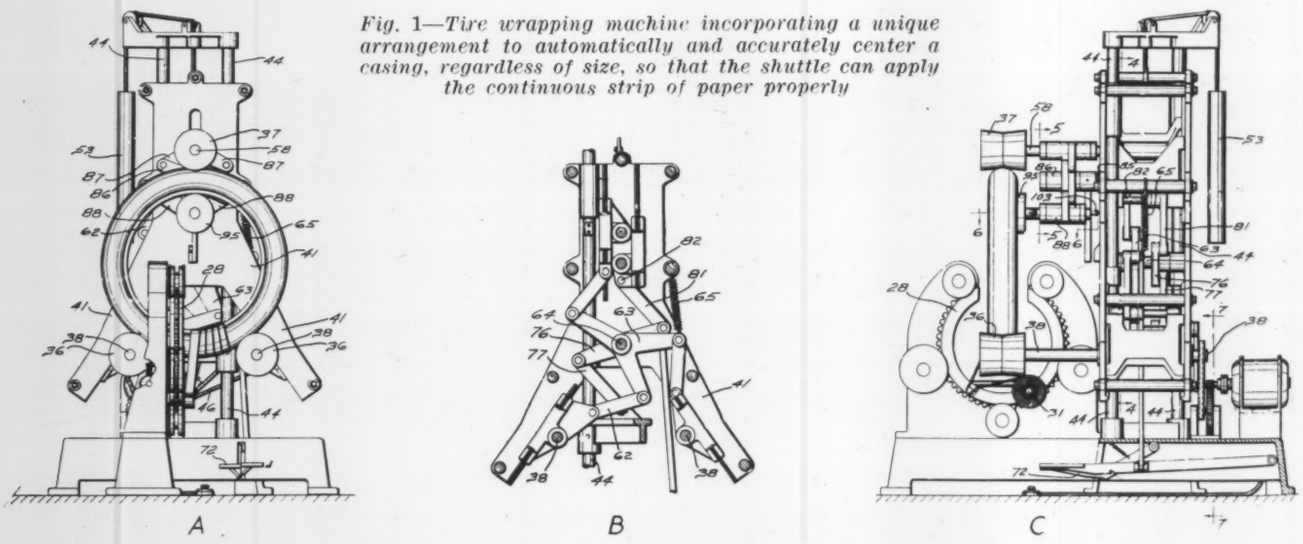


Fig. 1—Tire wrapping machine incorporating a unique arrangement to automatically and accurately center a casing, regardless of size, so that the shuttle can apply the continuous strip of paper properly

Before you give up your good idea as impossible...

EVERY day, good ideas are let die because they look impossible, or at least too costly. Give them a chance; do not let one opinion settle their fate.

A washing machine manufacturer had such an idea for a tub the like of which had never been made before. The tub wall was to contain fifteen deep flutes, and these flutes had to stop short of the bottom and top of the tub. Instead of giving up because of this difficulty, he brought his problem to G. P. & F.

The half century of experience, the engineering skill, the versatile equipment of G. P. & F. produced this tub at a cost which enables this manufacturer to offer a washer with exclusive advantages for a price competitive with ordinary washers.

Now, when price and sales features are so vital, don't pass up any chance. Let us give an opinion at least, especially since it costs nothing but a letter explaining what you want to do.

And on stampings or castings you have been using, send a blueprint for a bid. The experience and equipment of G. P. & F. may cut your costs.

The only washing machine with deep flutes on the tub to increase water agitation. Another exceedingly difficult stamping produced and porcelain enameled by G. P. & F.

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A-6802

ing blade, is embodied in an arrangement designed by Hans C. Jordhoy. Patent No. 1,840,319 recently was granted for the device, with Wood Newspaper Machinery Corp., New York, as assignee.

Shown in Fig. 2 is a conventional folder in which the new invention has been incorporated. The folding cylinder 10 is provided with a blade 11 which, at the folding instant, projects outwardly from the surface of the cylinder as depicted in the illustration. It is desirable that this blade extend exactly midway between the two folding rollers 12. The parts are driven by a gear 13, two pinions 14, and two driving pinions on the same shafts which mesh with two gears 15 on shafts 16 of the folding rollers. By this layout a drive is provided which is not disengaged or disturbed in any way by the movement of the folding rollers toward or away from each other in adjustment.

The two studs 19, on which supports 20 are pivoted to swing about the axes of the studs, are mounted on bosses on the folder frame. These two supports carry roller shafts 16. At the ends of two supports 20 spaces are provided for nuts 21 on which are mounted stops 22. Rod 23 passes through the nuts, and by its right and left hand screw threads moves the two stops toward or away from each other equally. This effects an equal adjustment of the rollers. Springs 26 hold the pivoted supports 20 toward each other and in engagement with stops 22.

Both ends of the folding rollers at either side of the machine are equipped with the same arrangement to enable the operator to set the rollers in the desired position by handwheels. A calibrated indicator gives a direct reading of the thickness of material the rollers are set to accommodate.

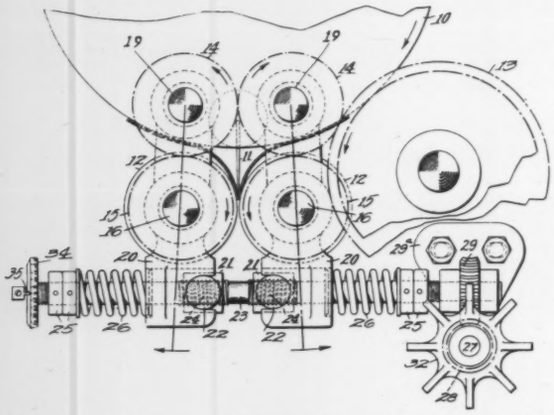


Fig. 2—Regardless of thickness of stock being folded, blade 11 always is midway between rollers 12

RECENTLY granted patents also include a novel antifriction coupling, the idea for which was originated by James P. Johnson for the J. P. Johnson Engineering Co., Cleveland, to which the patent has been assigned. The number of the patent is 1,844,471.

Two views of the unit are shown at *A* and *B*, Fig. 3. Disk 10 is provided with circular recesses 18, any number of which may be employed, although the inventor has designed his coupling with four. Balls 19 have a radius slightly greater than the depth of the recesses 18 and 20, the latter being machined in disk 14 which faces disk 10. This provides necessary clearance between the disks. During the eccentric rotation of disks 10 and 14, one being connected to the driving and the other to the driven shaft, balls 19 will have a rolling antifrictional engagement with recesses 18 and 20.

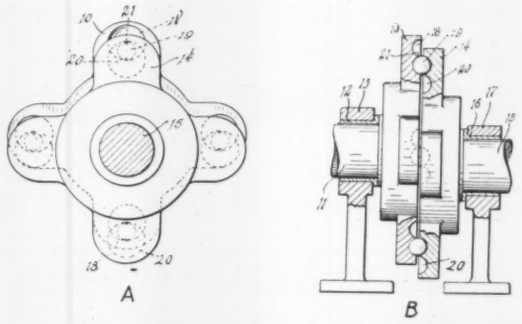


Fig. 3—Antifriction coupling employing disks which are held in engagement by balls

It should be noted that recesses provided in the adjacent faces of the disks are circular or continuous and provide a greater bearing surface for the balls than if the recesses were cup shaped. By employing a recess of this particular type a positive driving connection between the disks is afforded. By the use of balls as the connecting means between the disks, end thrust will be taken up without any danger of the balls tipping, the rolling action simultaneously being over the entire surface of the balls.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

CLUTCH—1,846,179. This patent covers a clutch which incorporates an electromagnet to move a cam member into operative relation with a cam. Assigned to United Engineering & Foundry Co., Pittsburgh.

LOCKING DEVICE—1,846,271. A locking device embodying strut members whereby adjacent work elements are positively secured against relative movement in either direction. Assigned to Shakeproof Lockwasher Co., Chicago.

ROLLER BEARING AND CAGE—1,846,836. The process of assembling conical rollers and a cage with a bearing cup having a conical raceway and a thrust rib at the end thereof, which includes disposing at the end of the bearing cup opposite the thrust rib, an assembling plate having a flange projecting into the bore of the cup, the rollers being mounted on the flange. Assigned to Timken Roller Bearing Co., Canton, O.

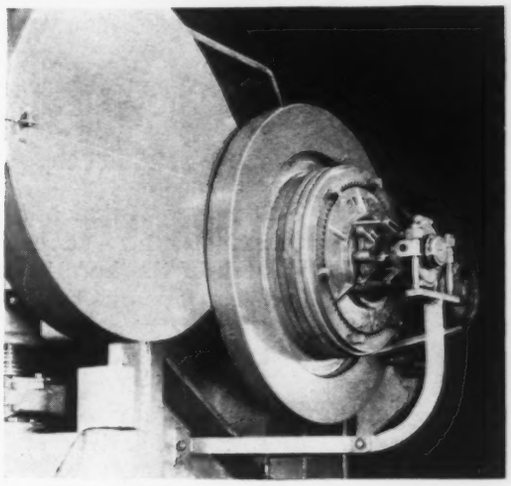
"We selected Twin Disc Clutches

because "regardless of cost, or any other item it was the best clutch obtainable.

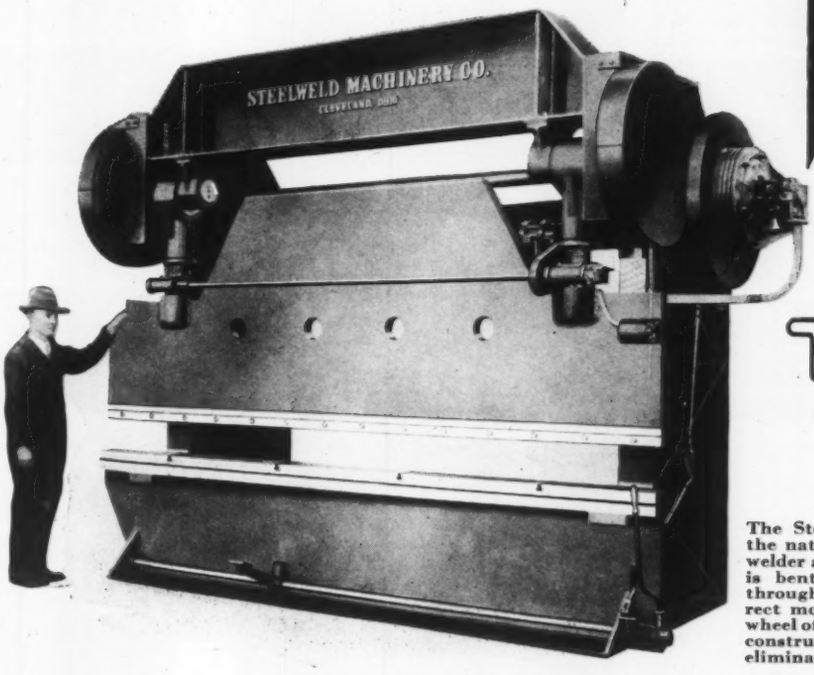
because "we could not possibly build as good a clutch ourselves for an equivalent cost.

because "of the variety of types and sizes of machines we have, it would have been difficult for us to keep on hand at all times, suitable clutches.

because "engineers prefer the disc clutch to a cone or any other kind of clutch, which while cheaper, would cause unwarrantable bearing pressure and would be difficult to keep in adjustment."



"STEELWELD BULLDOZERS and STEELWELD BRAKES use Twin Disc Clutches and expect to use nothing else," says Cyril J. Bath, President of The Steelweld Machinery Co., Cleveland, Ohio. "There are several sales points in the use of the clutch, and our customers have the use of a national organization in case of trouble, especially devoted to this one mechanical feature . . . the most important single item in the machine."



The Steelweld Bending Brake is the natural mate of the electric welder and is used wherever metal is bent. Anti-friction bearings throughout. High speeds and direct motor drive used in the flywheel of all-welded design. Special construction of ram and bed eliminates deflection.

The specialized experience of our Engineering Research Department is at your disposal. *Write* today for specific recommendations. Engineering Data Book sent on request. *Address Twin Disc Clutch Company, 1325 Racine Street, Racine, Wisconsin*

TWIN DISC CLUTCHES

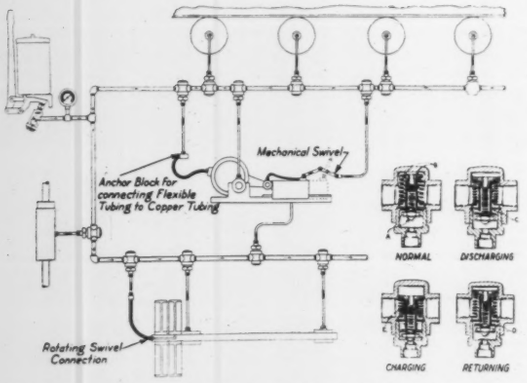
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Lubricator Gives Measured Quantities

MEASURED amounts of lubricant go directly and automatically into each bearing on the machine at a touch of the handle on the new Metro-Matic lubrication system being manufactured by Alemite Corp., Chicago. There is no waste of lubricant in the system. Only a metered amount goes into each bearing and when it is used up another measured amount is forced in.

The system employs a pipe line arrangement



Typical arrangement of new lubricating system which gives measured amounts of lubricant

whereby the lubricant is transferred under high pressure to each bearing. A measuring valve, located on the pipe line near the bearing, discharges a predetermined amount of lubricant at each operation of the pump.

Referring to the illustration, the operation of the system is as follows: From the previous operation there is already a supply of lubricant in chamber *A*, sufficient to lubricate the bearing thoroughly. When the pressure is increased throughout the system, the plunger *B* is forced downward causing lubricant in *A* to pass down the copper tubing to the bearing. As the plunger goes down, a vacuum is created in *C*, which space gets larger the farther down plunger *B* is forced. When the plunger is down as far as it can go and the lubricant is in the bearing, the increasing pressure in the pipe line forces the lubricant past the ball check valve *E* and down into chamber *C*. Then, as the pressure is released throughout the system, the plunger *B* rises and the lubricant directly above it passes the leather jacket *D* into the bottom chamber *A*. There it stays until the next working of the compressor, when the whole operation is repeated.

Develops Complete Line of Pushbuttons

PUSH buttons designed for general industrial applications are a recent development of General Electric Co., Schenectady, N. Y. The stations included in this line are divided into three general classes: Those which make momentary contact; those which maintain the contact; and a combination of both. With a momentary contact the circuit is completed or interrupted only as long as the operator's finger depresses the button. This is required when the station is used with a controller that must provide undervoltage protection. A maintaining contact holds the circuit open or closed as does an ordinary knife switch.

The devices consist of one or more of the following units enclosed in a case: Push button (momentary contact); selector switch (maintaining contact); and indicating lamp receptacle. Any combination not exceeding five of these units is available in wall-mounted stations. The same case houses the push button, selector switch or lamp receptacle.

A locking bar may be provided where desired

Some of the many types of push button stations available for industrial use

with means for attaching a padlock so that the "Stop" button may be locked open to prevent accidental starting. Several types of stations are shown in the accompanying illustration. These

SEVENTEEN YEARS

IN A COAL MINE!

Actual photograph of SKF Bearing (type now obsolete) that served for seventeen years in a five-ton Jeffrey locomotive in the mines of the North East Coal Company, Paintsville, Ky.

SKF BEARING UNDER TRYING OPERATING CONDITIONS . . . ESTABLISHES SERVICE RECORD

Seventeen years ago this SKF Bearing went into a five-ton Jeffrey mining locomotive in the mines of the North East Coal Company, Paintsville, Ky. It operated steadily. There were no protracted shut-downs to make its job easier. And when finally, at the rare old bearing age of seventeen years, it was removed, it was not due to breakage or chipping, but because it had worn down gracefully.

That sort of SKF performance has convinced American Industry that it is the *use* not the *price* of a bearing that determines real bearing economy. And manufacturers of bearing-equipped products should consider this important fact. The performance of this SKF Bearing was very definitely a contributing factor in the performance of the Jeffrey locomotive of which it was a part.

It does not pay to economize on bearings from any point of view. Usually it costs more to replace a cheap bearing than to buy the best that SKF ever produced. SKF Industries, Inc., 40 East 34th Street, New York, N. Y.

SKF

BALL AND ROLLER BEARINGS

A PROMISE IS ONLY A PROMISE... *PERFORMANCE IS HISTORY!*

2832

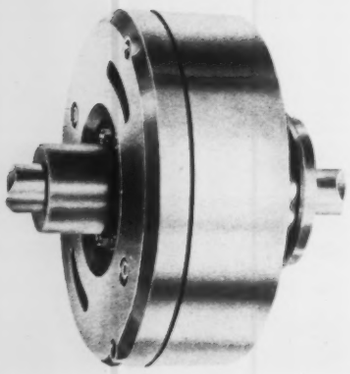
also are available in a modified form for mounting on the back of 1/16 to 2-inch panels. Only the buttons extend through the panel, and they are protected by the same collar and designated by the same nameplates as are used on the wall-mounted stations.

Clutches Require Little Space

DESIGNED to provide more power with smaller physical dimensions, the new magnetic friction-type clutch brought out by Dings Magnetic Separator Co., Milwaukee, has contact faces on both sides of a spring disk which are compressed between the magnet and armature elements when the coil is energized. Theoretically the power transmission of this clutch, shown herewith, is double that of a single friction contact face, but actually it is of approximately 75 per cent greater torque with the same magnet strength.

All provisions are made for adjustment to compensate for wear of contact faces. Light springs on the armature holding bolts serve to expel the armature when the coil is de-energized, thus assuring ample clearance between the two clutch elements. The clutch is made with and without ball bearings between the hubs of the two clutch members as installation conditions might require to insure alignment.

The company also has brought out a single spring disk clutch following the same general construction given in the foregoing, but having three friction contact faces with the consequent increased torque and power transmission.



Magnetic friction type clutch is designed to provide more power with smaller physical dimensions

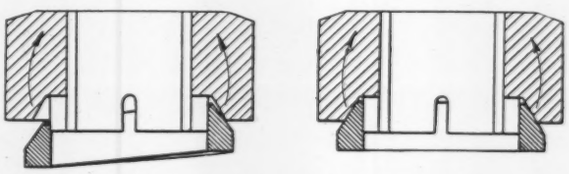
Lubricant Makes a Metal Deposit

A LUBRICANT which makes a metal deposit, preventing fine surface corrosion and wear, is a recent innovation of Lubriplate Corp., Chrysler building, New York. The lubricant deposits a film of zinc on all working surfaces but never builds up beyond a predetermined point. This materially reduces high-speed operating temperatures and prolongs the life of equipment. It is free from acid and other destructive fillers, and permits no oxidation.

Lubriplate, as the material is known, is used for gears, open and closed type; plain, ball and roller bearings; chain drives in all types and speeds; and for stamps and dies.

Self-Locking Nuts Have Two Parts

SELF-LOCKING nuts which consist of two component parts assembled into a single working unit are being manufactured by International Safety Lock Nut Corp., 67 Broad street, New York. The unit, shown herewith, consists of a nut proper and an elastic steel compensator.



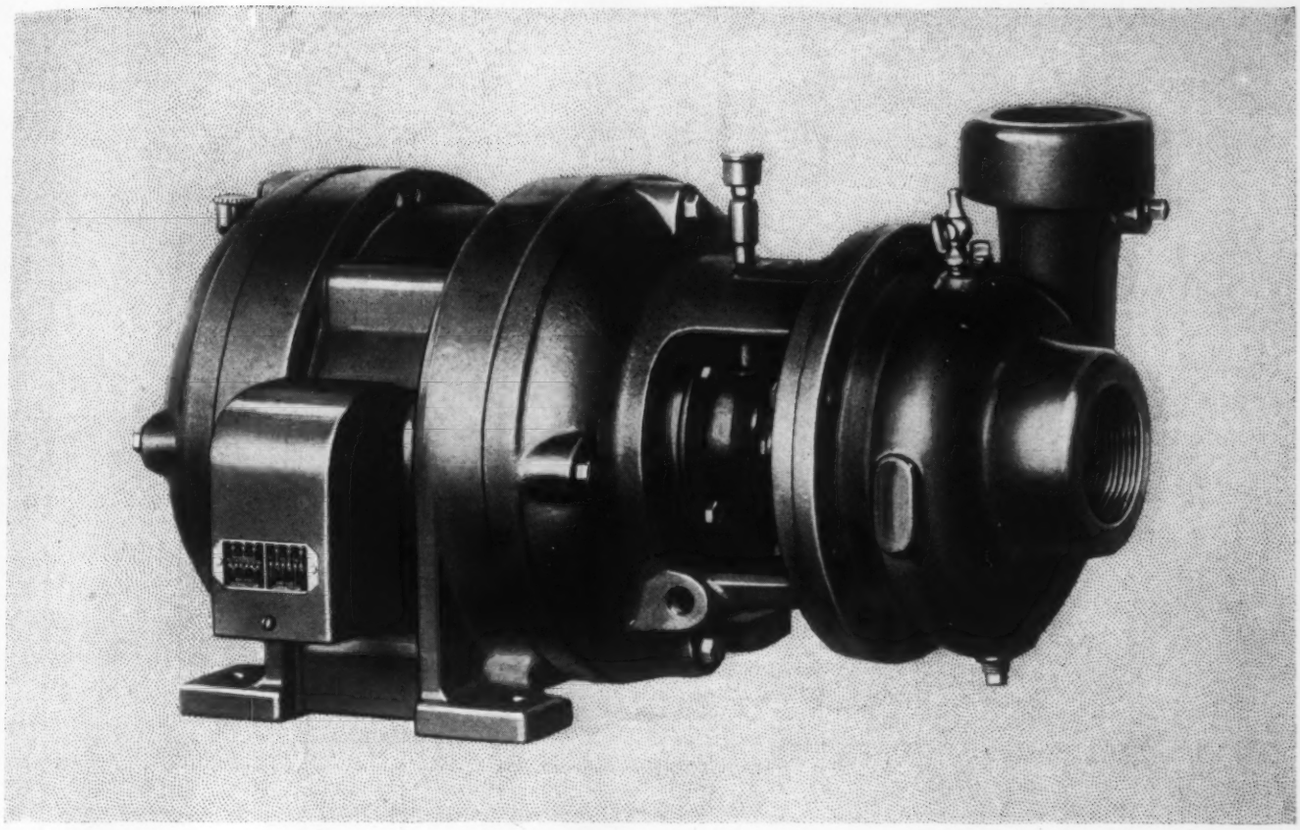
Lock nut before engagement, left, and after being screwed down, right

The nut on the seating face is provided with a conical groove containing a ring which is divided into four equal segments by slots. The compensator is an elastic steel washer shaped to fit into the groove of the nut. As the nut is screwed up with a wrench, the compensator flattens out and acts progressively on the ring segments, pressing them more and more on to the threads of the bolt. In the fully clamped condition the compensator is no longer helicoidal, but is circular.

Four-Way Valves Are Balanced

FOUR-WAY valves which have perfect hydraulic balance, making it impossible for them to bind due to pressure and assuring more sensitive operation are being manufactured by Vickers Inc., 7744 Dubois street, Detroit. The valves, which are extremely compact, are incorporated easily in the design of hydraulically operated equipment.

There are three types of 4-way valves available. The one illustrated at the left is the latch controlled valve which makes one complete cycle and then stops; it is adapted particularly to press operations, hydraulically operated furnaces, etc. The operator starts the machine manually in one direction; at the end of stroke a stop trips the latch and allows an internal spring to shift the valve to reverse position. When the end of



Type SSU—A Useful, Small Pumping Unit. Capacities—30 to 400 g.p.m.

TYPE SSU Pumping Units, while scarcely larger than a motor alone, handle capacities from 30 to 400 gallons per minute, for heads up to 100 feet. Being small and light in weight, they are easily transported and any rigid support is sufficient as a foundation. Because the pump impeller is attached to the motor shaft, alignment troubles are eliminated. The motor housing near the pump is completely closed so no liquid can get into the motor windings. These type SSU pumps can be furnished with standard open type, enclosed fan-cooled or explosion-proof induction motors, and with single phase motors up to the 5 h.p. size. These units were brought out in 1927 and the line is exceptionally complete providing the most economical pump for any condition within the range carried. Pumps for general use are described in Bulletin 1647-A, for oil field service in Leaflet 2143.

Centrifugal Pumps

The Allis-Chalmers line consists of low, moderate, and high head single stage pumps of 1″ to 72″ discharge, multi-stage pumps for working pressure up to 1500 pounds, high efficiency paper stock pumps, and pumps for special applications.

Allis-Chalmers Manufacturing Company, Milwaukee

ALLIS-CHALMERS

return is reached the machine is stopped by the valve.

The pilot operated valve with manual and mechanical pilot valves constitutes the center group shown. It provides remote control with-

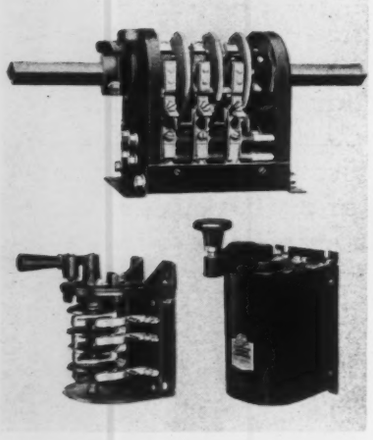
Types of four-way valves which have perfect hydraulic balance

out the use of levers, links, etc., and can be placed out of sight or wherever most convenient. It has simple external adjustments for controlling reversing speed—this feature is used to eliminate shock from rapidly moving tables. A manually operated 4-way valve is shown at the right.

Introduces Drum Controllers

A NEW line of alternating and direct current across-the-line type reversing drum controllers for monorail hoists, auxiliary machine tool motors and miscellaneous applications has been developed by Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. These new controllers are made in two or three pole types; with radial or rope lever operating mechanism; self-centering or nonself-centering mechanism; and with or without either main limit switch protection or pilot circuit interlocks.

Construction features include: easy operation;



Small and compact design features alternating and direct current across-the-line type reversing drum controllers

small and compact design; light weight; sturdy drum construction; easily removed, nonstubbing contact fingers; slot type mounting holes; ease of change from self-centering to nonself-centering; and shaft extension of six inches beyond both ends of drum when rope lever drive is furnished.

The types which have pilot circuit interlocks can be used as a reversing switch in conjunction with a separate automatic starter or as a magnetic contactor to provide limit switch selection in either direction or magnetic main line feature.

Heating Unit Operates Lubricator

AN AUTOMATIC oiling system for industrial machinery and automobile chassis which operates electrically without pump or moving parts has been designed by Motor & Plane Accessories Inc., Detroit. The device consists of an oil tank equipped with a heater unit which is separated from direct contact with the oil. When the machine that is to be lubricated is started,

Lubricator is operated by an electric heating unit shown at the top

the Westinghouse electric heater unit inside the tank is turned on automatically.

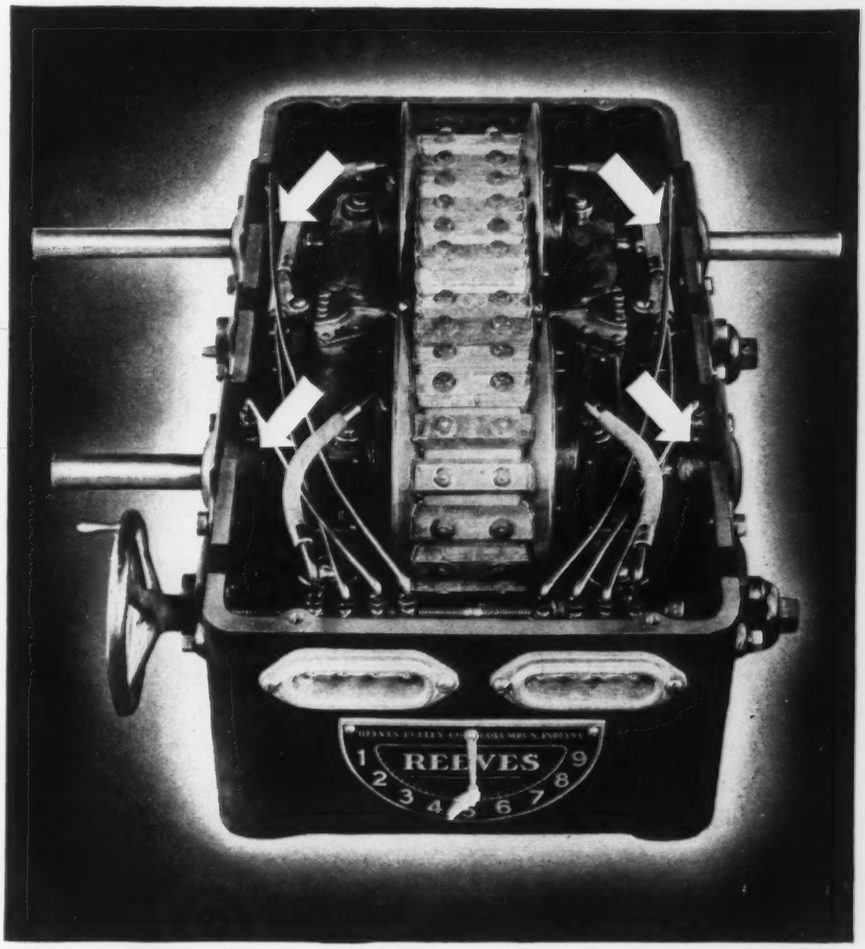
The temperature of the oil is raised which causes expansion and forces oil out of the tank to the bearings where proper metering devices control the flow of oil. After the temperature has reached 150 degrees a thermostat breaks the contact and allows the oil to cool to 100 degrees. At that temperature the thermostatic switch again makes contact.

During the cooling process a vacuum occurs which is utilized to refill the tank from a central supply or reservoir. To prevent drawing oil back from the bearings, a check valve is used in the main feed line. The unit is shown in the accompanying illustration.

Announces Aluminum Electrode

DESIGNED for use with either metallic or carbon arc welding, the new electrode for welding aluminum developed by Lincoln Electric Co., Cleveland, can be used for fabrication of either sheet or cast material. The electrode is a 5 per cent silicon aluminum alloy. It is provided with a coating which prevents excessive oxidation and will dissolve any aluminum oxide

Longer Life *and* Less Attention *with* Fafnirs on Reeves Transmissions



Four Fafnir Wide Inner Ring Ball Bearings mounted in oil-tight, dust-proof housings which in turn are mounted in recesses in the frame sides to support the constant and variable speed shafts in the Reeves Variable Speed Transmission

WIDELY varying service conditions must be satisfied by these variable speed transmissions. Long hours, even weeks or months of continuous service with little or no attention are more the rule than the exception. Dust and grit are ever present. High temperatures are common. Loads are constantly varying and so are the speeds.

Truly this application is a real test for bearings. And it is significant that Fafnir Wide Inner Ring Ball Bearings have given complete satisfaction—to Reeves and Reeves' customers alike. Over 100,000 have been successfully employed here.

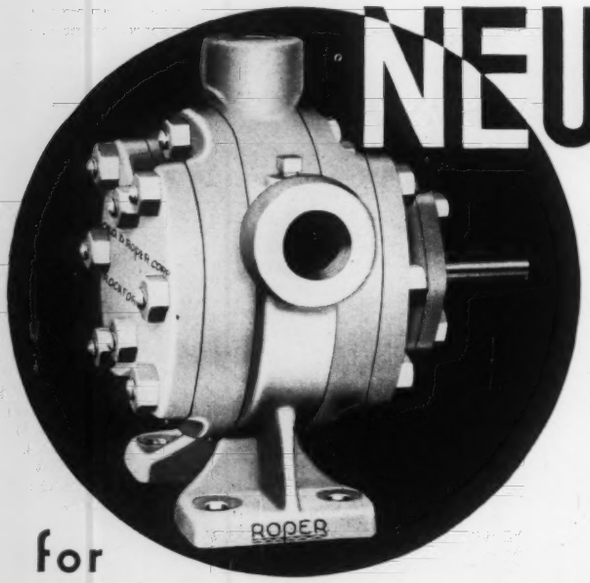
Morever, the machine design was actually simplified by the ease of application and mounting of these Fafnirs. No shaft shoulders, lock-nuts, sleeves or adapters are used. The self-locking feature of the wide inner ring provides for a perfectly tight fit to a plain shaft.

With this simplicity of installation is combined the protective anti-friction qualities of full capacity ball bearings. Wear is virtually banished. Heavy loads, shocks and thrusts are sustained indefinitely. No bearing maintenance is needed, except normal lubrication.

Fafnir Wide Inner Ring Ball Bearings are available in a wide variety of sizes. They have been applied to machinery of every description. A survey of your products may reveal applications where worthwhile economies could be effected. Our engineers would be glad to consult with you. This service is offered without any obligation.

THE FAFNIR BEARING CO., NEW BRITAIN, CONN.
Atlanta Chicago Cincinnati Cleveland Dallas Detroit
Los Angeles Milwaukee Newark New York Philadelphia

FAFNIR BALL BEARINGS



NEW

for hydraulic drives...a QUALITY pump at LOW COST

Especially adaptable to various machine tool uses such as chucking rapid traverse on threading, etc.; to light elevators and portable truck lifts; to light press work; and to other hydraulic drives requiring pressures up to 300 pounds per square inch, intermittent—250 pounds, constant. A quality pump throughout, incorporating famous Roper mechanical features such as herring-bone drive gears, ball-bearing design, automatic bearing lubrication. Built in nine sizes. Wide range of capacities, and flexibility of mounting designs, permit almost unlimited applications. Backed by Roper's hydraulic research, field experience, and engineering service to customers. This lower-priced series supplements Roper's already extensive and varied line of pumps for hydraulic drives. Investigate!

WRITE TODAY for full performance and mechanical details. No obligation—address

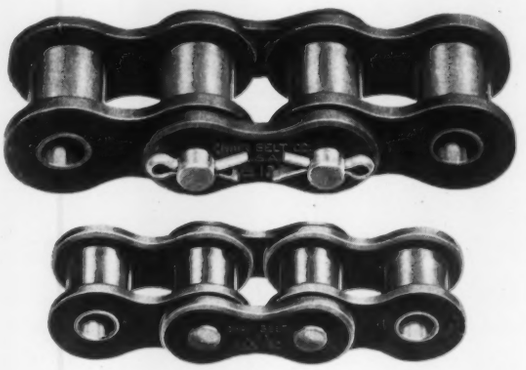
ROPER

Geo. D. Roper Corp.
480 Blackhawk Avenue, Rockford, Ill.

that might be formed. In its use a short arc of approximately 20 volts should be held with the coating practically in contact with the work. "Aluminweld," as the electrode is known, is produced in four sizes, 3/32, 1/8, 5/32, and 3/16-inch, in 14-inch lengths.

Roller Chains Are Positive in Action

ROLLER chains in single and multiple widths for use in all chain applications now are being marketed by Chain Belt Co., Milwaukee. The new line, known as Rex roller chains, includes a wide range of sizes made in the riveted type and also in the detachable or cotter pin style. Single chains of both types are shown in the accompanying illustration.



Detachable or cotter pin and riveted type of roller chain recently introduced

In the new chains an unusual amount of attention has been given to appearance. They are made of specially selected steels, accurately formed and carefully heat treated. Both materials and design conform to the standards of the American Society of Mechanical Engineers, Society of Automotive Engineers, and American Gear Manufacturer's association. The chains have been rated at 98 per cent efficient.

Clutches Protect Against Overloads

CLUTCHES which will permit the driving motor to come up to speed without load, and which also give protection against overload shocks are now being offered by Ramsey Chain Co., Albany, N. Y. The clutches, shown herewith, operate on the Pulvis principal, described in the April and November 1930 issues of MACHINE DESIGN. This principle consists of the sure, gradual transmission of power by centrifugally increasing density of hardened steel

POP AND LAD LEARN HOW TO BUILD BASES....

"Here's how they start to build a triple drum hoist, from the ground up. They simply assemble standard shapes and plate, and trot in their 'Stable-Arc' welder.

"I can see where in this case it saves them a lot of time and annoyance which would be their lot if they chose to use a cast frame.

"If Lincoln ever conducts a slogan contest my entry will be 'Buy a welder instead of a pattern.'"

"Right—and let us take a lesson from this machinery base and put it to work for us. Some machine builders even now are benefitting from similar lessons.

"We shouldn't tie up our scarce money in patterns when we can get a stronger, stiffer and lighter construction this way.

"Also, changes in design keep popping up and this method enables us, at no additional expense, and no interruption, to introduce them into production as they come along.

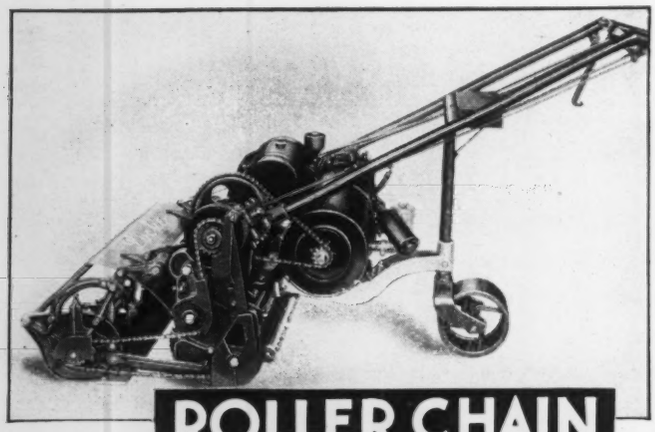
"Then, too, on slow moving items we can make up the bases as we get the orders and not be tied down to tie-ups."

LINCOLN

THE LINCOLN ELECTRIC COMPANY, CLEVELAND, OHIO

Largest Manufacturers of Arc Welding Equipment in the World

W-10



ROLLER CHAIN
for PORTABLE
EQUIPMENT

This Locke Power Mower is better, more reliable and less expensive because it is driven by Duckworth Roller Chain. Equipment of this general character must be efficiently driven and capable of standing severe strains and shocks. Roller chain answers the need better than anything else.

Designers are specifying more and more roller chain. Manufacturers welcome it because it is inexpensive and easy to apply. Users like it because it is trouble-proof.

There are many sizes of Duckworth Roller Chain from 3/8" to 1½" pitch, in single and multiple strand type. We also design and manufacture special types and sizes, of special alloys and bronzes to withstand unusual conditions. Consult a Duckworth Engineer for details.

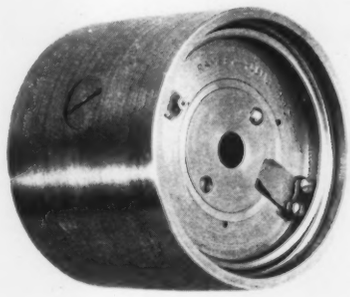
The Duckworth Chain Catalog contains a wealth of valuable engineering data of great service to designers. You should have a copy handy. Write us or ask your nearest Duckworth dealer for a copy.

BALDWIN-DUCKWORTH CHAIN CORPORATION
Duckworth Division, Springfield, Mass.
Baldwin Division, Worcester, Mass.

BALDWIN
DUCKWORTH

shot against driving and driven elements of the clutch.

The unit can be made as part of the driving member of industrial drives such as silent or

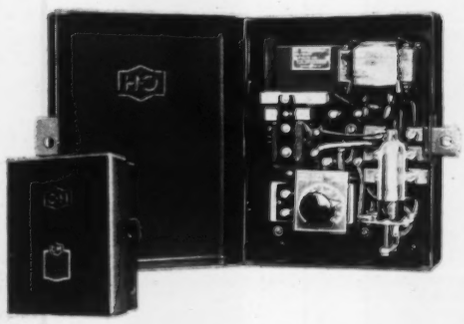


Unique clutch can be incorporated as part of the driving member of machine drives and will permit the motor to come up to speed without load

roller chain, flat belt, multiple V-belt, all gear types, or as a coupling on direct connected drives. The Ramsey company now exclusively controls the manufacture and sale of these clutches in the United States.

Designs Timing Device for Welders

A NEW timing device for spot, projection and other forms of resistance welders is a recent development of Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. The new tube timing welder control, known as bulletin 13101, is said to eliminate all guesswork on the

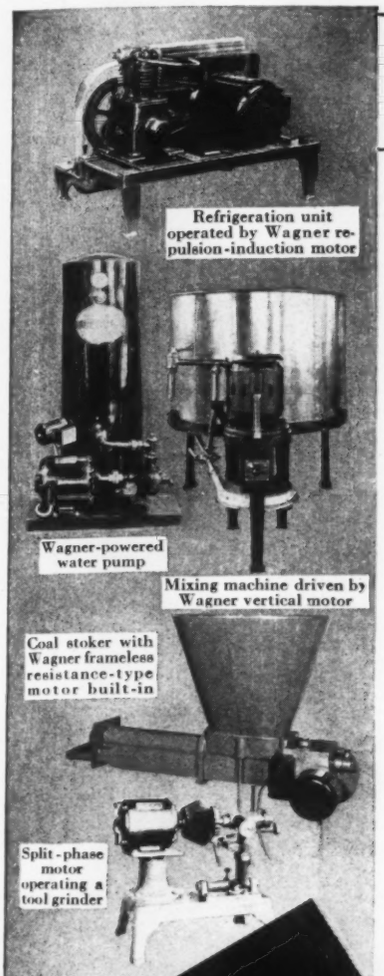


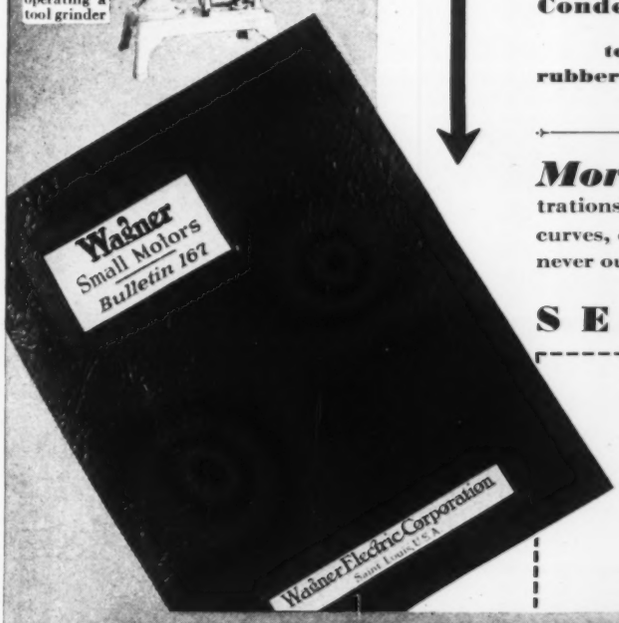
Unit for controlling timing on resistance welders to a close degree

part of the operator, enabling unskilled workmen to produce successful welds and practically eliminate rejects and throw-outs.

The timing is adjusted by a knob, shown in the accompanying illustration, inside the enclosing case. The control requires only a small mounting space and operates on 110 to 550 volts alternating current. Vibration, severe or intermittent service will not affect the device. Use of an electronic tube makes possible an accuracy of better than a fraction of a second and the device has an adjustable range up to 16 seconds.

Get this *Valuable Information* on SMALL MOTORS


Refrigeration unit operated by Wagner repulsion-induction motor
Wagner-powered water pump
Mixing machine driven by Wagner vertical motor
Coal stoker with Wagner frameless resistance-type motor built-in
Split-phase motor operating a tool grinder



If you manufacture, sell or use machines operated by electric motors, you will learn from this new Wagner booklet . . .

the latest information on motors and their application to machines. Whether you are engineer, manufacturer or purchasing agent, this booklet gives you a clear picture of what to expect from each type of motor. It will help you to design and manufacture better machines.

The booklet fully describes all types of small motors, and gives their electrical characteristics to help you decide when and how to apply them. Among the types of motors are the following:

Repulsion-Start-Induction . . . Squirrel-Cage Condensor . . Split-Phase . . Direct-Current

totally-enclosed, drip-proof, ball-bearing, rubber-mounted, flange-mounted, skeleton-frame, vertical, hazardous-gas.

More than a Bulletin . . . Full of illustrations, detailed description, graphs and speed-torque curves, etc. Can be kept up-to-the-minute at all times—never out of date.

SEND FOR IT TODAY!

Wagner Electric Corp. ▪ ▪ 6400 Plymouth Ave. ▪ ▪ St. Louis, Mo.

Please send copy of booklet describing Wagner Small Motors.

Name and Position_____

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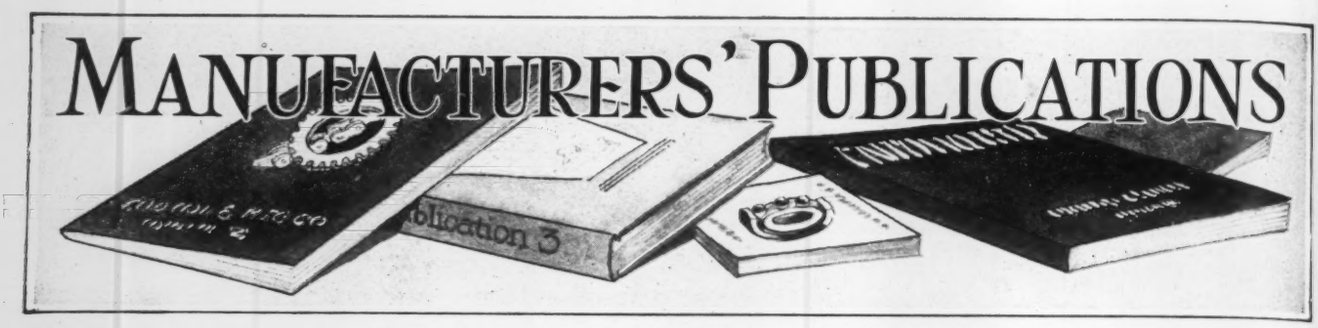
MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (STEEL)—Circle "L" alloy steels for high stresses and wear resistance, and stainless steel alloys for corrosion and heat resistance are covered in two new bulletins of Lebanon Steel Foundry, Lebanon, Pa. Descriptions, physical properties and alloy constituents are given for the various materials available.

BEARINGS—Hoover Steel Ball Co., Ann Arbor, Mich., presents in *The Hoover Sphere*, volume 1, number 1 of which appeared in January, its method of testing bearings by radio.

BEARINGS—Shafer Bearing Corp., Chicago, is offering a new bulletin, No. 501, on its line of radial-thrust roller bearings, both single and double row. The bulletin, a revision of an earlier publication, includes many new sizes. A speed factor table also has been added, making it possible to figure load ratings at intermittent speeds.

BEARINGS—Tyson Roller Bearing Corp., Massillon, O., has just published the second edition of an engineering manual which is available to design executives and engineers. The 26-page bulletin contains essential information on the application of the cageless roller bearing for all antifriction purposes. Tables of engineering data, dimensions, and similar material are included.

CAST PARTS (STEEL)—National-Erie Corp., Erie, Pa., in a current leaflet gives engineering data on its heat treated and hardened gears and its alloy steel castings.

CLUTCHES—Morse Chain Co., Ithaca, N. Y., has prepared a comprehensive bulletin, C66, on Morse-Pullmore clutches. This clutch is a multiple disk friction drive unit made in six standard sizes. Centrifugal force has no effect on its action, and it can be operated at high speeds.

CONTROLS (ELECTRICAL)—High tension across-the-line starting switches are described and illustrated in bulletin No. 726 of Allen-Bradley Co., Milwaukee.

CONTROLS (ELECTRICAL)—New drum controllers of the across-the-line type are covered in recent bulletins of Cutler-Hammer Inc., Milwaukee. The controllers for direct current service are described in bulletin 5441, and for alternating current in bulletin 9441.

DESIGN DEPARTMENT EQUIPMENT—C. F. Pease Co., Chicago, presents in its latest catalog, M-31, its complete line of blueprinting machines and accessories, blueprint paper and drafting room furniture. The machines described include the new model 25, a continuous machine that will make blueprints, negatives, blue line and brown line prints at a printing speed of 4 inches to 12 feet per minute.

DRIVES—Steel thimble roller chains manufactured by Jeffrey Mfg. Co., Columbus, O., are presented in a new catalog, No. 525, of the company. The various types of chain, for drives, elevators and conveyors, are described, and physical dimensions and engineering data are given.

DRIVES—An unusually attractive catalog, No. 440, has been prepared by Chain Belt Co., Milwaukee, on Rex roller chains and sprockets. The catalog gives characteristics of the chains, applications, engineering data, dimension sheets, capacities, and similar information. Single and multiple width chains in a number of different styles are covered.

DRIVES—Chains and sprockets manufactured by Baldwin-Duckworth Chain Corp., Springfield, Mass., are well presented in a new 80-page catalog of the company. This book on power transmission equipment shows a complete line of single and compound roller chains and sprockets from ⅜ to 2-inch pitch and in addition contains charts and tables of interest to those who plan or design chain drives.

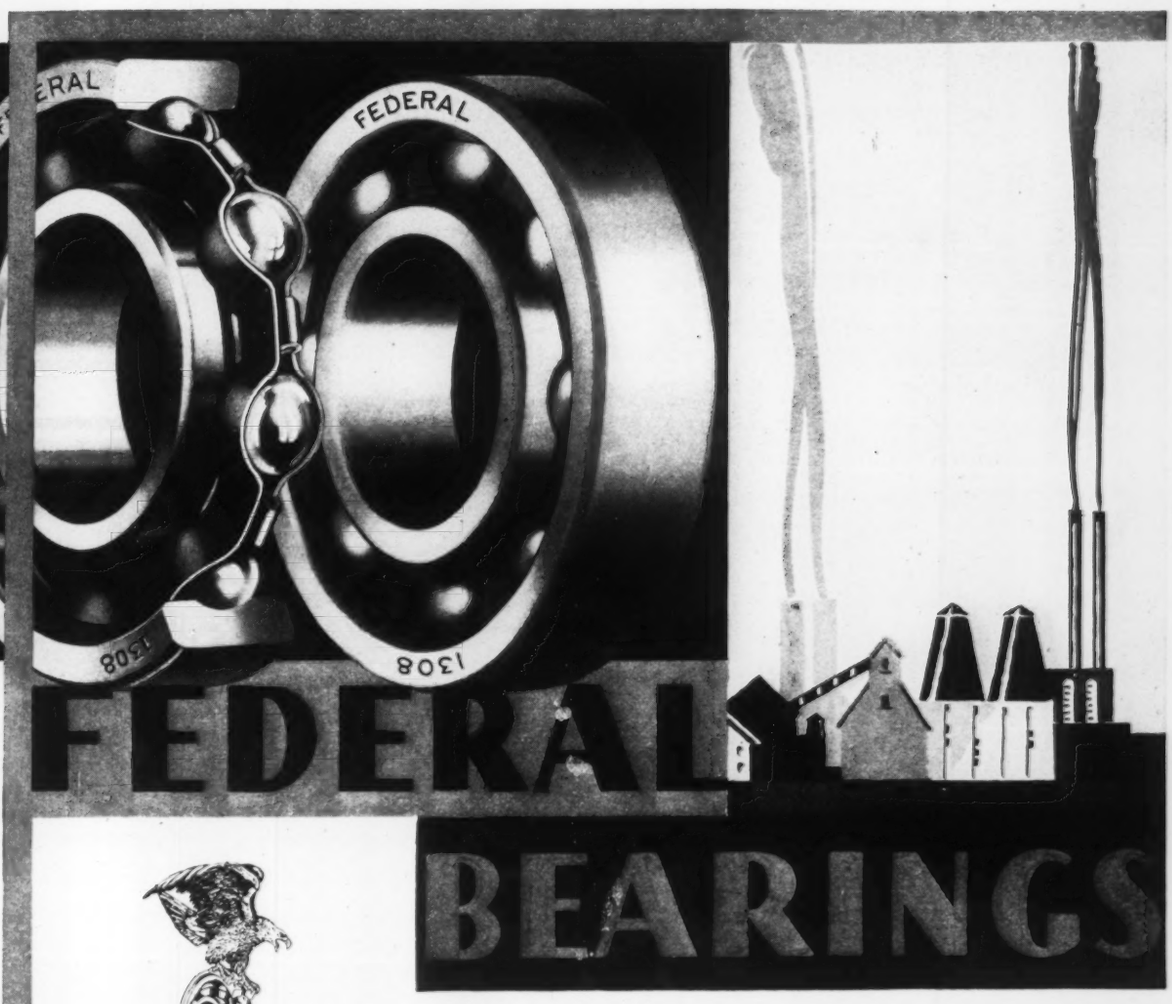
FASTENINGS—An outline of the properties of Monel metal bolts is given in bulletin T-1 of the International Nickel Co. Inc., New York. The bulletin includes a description of available types, determination of stresses and bolt resistance, corrosion resistance, and considerable engineering data.

FASTENINGS—Parker-Kalon Corp., New York, has issued an attractive booklet on its self-tapping sheet metal screws, metallic drive screws, screwnails, and masonry nails. The booklet gives a complete description of the fastenings including uses, methods of assembly, properties, stock sizes, and advantages. Tables and charts give the machine screws which are the nearest equivalent to the self-tapping products and their comparative strength.

MATERIALS (COMPOSITION)—Chicago Molded Products Corp., Chicago, has issued catalog No. 101 giving the story of Bakelite molded parts. The catalog includes method of manufacture, physical properties, tables of engineering data, standard parts available, and "dont's for designers."

MOTORS—Electric governor controlled constant speed universal motors, with and without integral gear reducers, are discussed in bulletin No. 1013 of Bodine Electric Co., Chicago. The bulletin gives a complete description of the motor and its operating characteristics including form R with speed adjustable while running, and form S with speed adjustable at standstill only.

THRUSTORS—An hydraulically operated mechanism that produces a straight line constant-pressure thrust from an electric motor drive is presented in a well prepared booklet, GEA-1262B, by General Electric Co., Schenectady, N. Y. Applications of the thrustor, which can be installed on practically any type of equipment, are shown pictorially and described.



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FEDERAL BALL BEARINGS are selected for one outstanding reason . . . exceptional quality. These bearings are made with utmost care and precision. Many times tested before leaving the great Federal plant. Only the finest steels are used—steels that are scientifically heat-treated and thru-hardened.

"FEDERALS" are the finest bearings that human skill can produce. That is why they are selected by those who know most about bearing values and service. For economy, efficiency and reliability . . . use "FEDERALS!"

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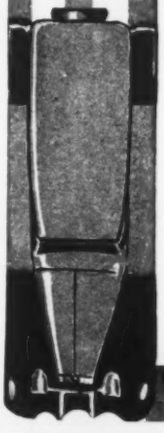

WHEREVER BEARINGS ARE USED